Light and Lighting

Industrial, Commercial, Highways, Domestic, etc.

Vol. XLIII.—No. 1. JANUARY, 1950 One Shilling

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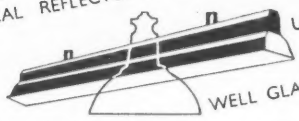

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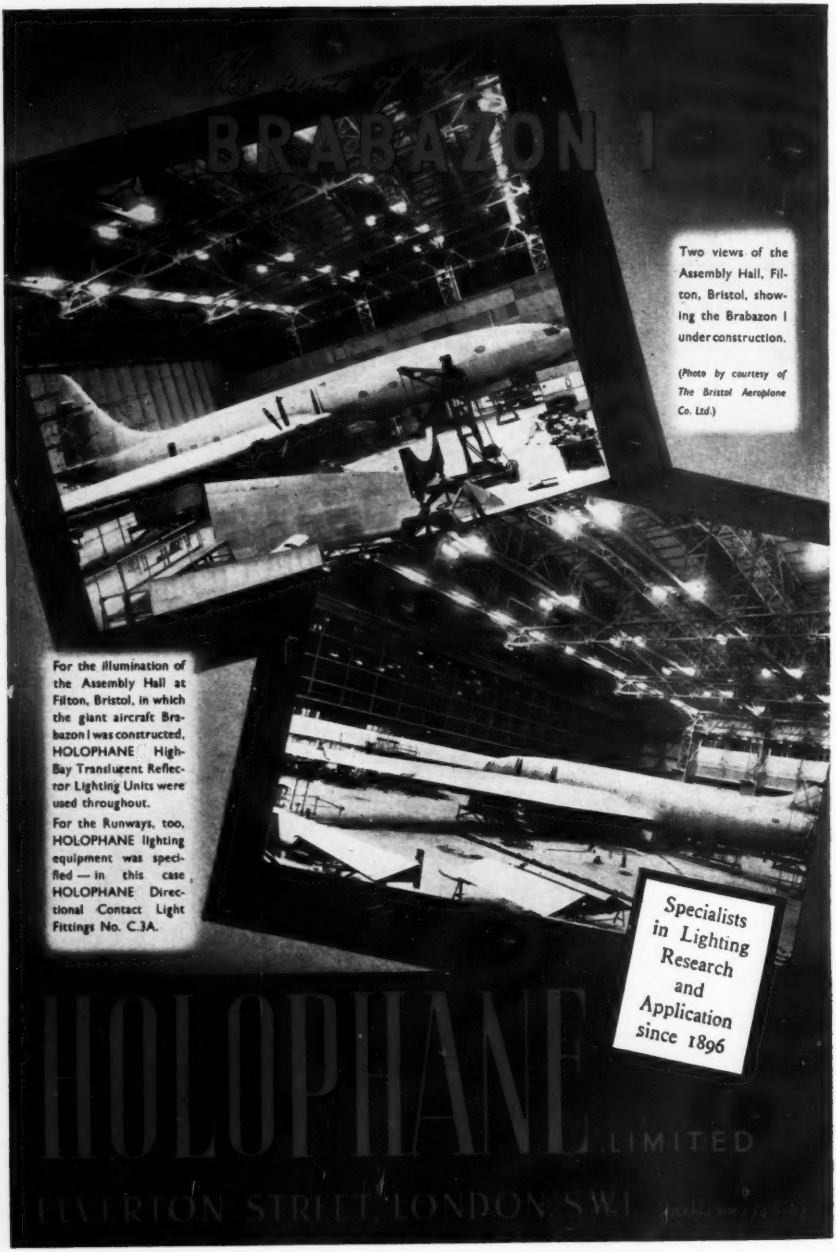
BRABAZON 1
Two views of the Assembly Hall, Filton, Bristol, showing the Brabazon I under construction.
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Vol. XLIII.—No. 1 **January, 1950** **One Shilling**

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Mid-Century Survey

THE first half of the twentieth century has been a period of world-shaking events, and of unparalleled achievements in science and technology. Some of these achievements, as aerial transport and radio communications, are so remarkable and so far-reaching in their effects as to over-shadow many other important advances. Lamplighters—familiar figures in 1900—have all but vanished. Gas lighting is with us still, though much improved. The carbon arc lamp has disappeared from our streets and the carbon filament lamp from our homes and workplaces. The efficiency of general purpose electric lamps has been greatly increased, and, to-day, fluorescent lamps give us light abounding where, at the dawn of the century, only a meagre illumination could be had for a corresponding consumption of power. Not only this, but substantial improvements have been made in equipment for controlling the distribution of light; and illumination can now be measured by anyone as simply as temperature can be, and with an instrument as handy as a thermometer. In the design of lighting, art is now partnered by science—to the undoubted advantage of the user, and it can be predicted confidently that a wide extension of good practice in lighting will mark the second half of the present century.

Notes and News

I.E.S. Summer Meeting

The I.E.S. have just announced the programme for their second provincial Summer Meeting which this year is to take place from May 16-19 at Buxton, in Derbyshire. All who took part in the 1948 meeting will, without doubt, mark this event in their diaries as one which they must attend.

The programme opens on the evening of Tuesday, May 16, with a reception by the Mayor of Buxton, with dancing from 8.30 until 11.30. We are glad to see that once again the Summer meeting is to open in a manner which gets all the delegates who come from all parts of the country, and from overseas, together in an informal way right at the beginning of the meeting.

The papers to be presented are of the same high standard set at the Harrogate meeting and will be of considerable interest not only to all members of the I.E.S. but to many others who are interested in particular lighting problems.

The meeting will be officially opened on the Wednesday morning by the Mayor of Buxton, following which a lecture on "Visual Deception" will be given by Dr. L. A. Sayce. Dr. Sayce is Superintendant of the Light Division of the National Physical Laboratory and an authority on the subject on which he will be speaking. This lecture is of a popular nature as was the closing lecture at the previous summer meeting. On this occasion, however, it has been decided to open the meeting with this lecture instead of making it the final item.

With regard to the technical papers steps have been taken to deal with the one major criticism of the Harrogate meeting, i.e., that insufficient time was allowed for the adequate discussion of papers. The programme has, therefore, been arranged so that one paper only is presented each morning or afternoon. The first technical paper will be on the Wedday afternoon when Mr. R. O. Ackerley will be dealing with "Floodlighting." This subject is one which is particularly welcome at the present time when after a lull of many years it is expected that in 1951 floodlighting will be more popular than ever before.

On the Thursday morning there is a paper of considerable interest to lighting engineers and to those who are concerned with the textile industry, the paper being on "Lighting of Fibre and Fabric," by Mr. H. Hewitt. In the afternoon will be held the annual general meeting of the Society following which, in accordance with the Society's practice for many years, a prominent lighting authority from overseas has been invited to address the Society. This year the address is to be given by Mr. Ivar Folcker, who is chairman of the National Illumination Committee of Sweden and a vice-president of the International Commission on Illumination. His subject will cover lighting practice in Sweden, and in view of the progress made in decorative and architectural lighting in that country during recent years, it should be most instructive.

The remaining papers, to be given respectively on the morning and afternoon

Next I.E.S. Sessional Meeting in London

The next I.E.S. sessional meeting in London will be held at the Lighting Service Bureau, 2, Savoy-hill, W.C.2, at 6 p.m. on Tuesday, February 14.

At this meeting a paper on "The Dimming of Fluorescent Lamps and its Application to the Theatre" will be read by Dr. J. W. Strange. This paper deals with the circuits which have been developed to enable fluorescent lamps to be dimmed, colours which can be produced, and the application of fluorescent lamps to stage lighting.

of Friday, May 19, are "Stage Lighting in the Post-war Theatre," by Mr. L. G. Applebee, and "Street lighting," by Mr. J. M. Waldram. We have little doubt but that both of these papers will attract good audiences.

Social events, in addition to the opening reception, include the President's reception on the Thursday evening, a mannequin parade and an afternoon tour to Haddon Hall for the ladies, and a general tour of the Derbyshire Dales on the afternoon and evening of the last day, Friday, May 19. This latter tour will begin on the conclusion of the final paper at about 4 p.m. In addition for golfers there will be play for the Dow Cup, further details of which are given elsewhere in this issue. It will be noted that there will be no official dinner at this meeting, its place being taken by the President's Reception.

The N.P.L.: 50 Years Old

This year is the jubilee of the National Physical Laboratory, the establishment of which may be said to date from the appointment of its first director, R. T. Glazebrook, on January 1, 1900, although the formal opening at Bushey House by King George V and Queen Mary (then Prince and Princess of Wales) did not take place until March 19, 1902.

Kew Observatory was originally included as part of the laboratory, and the work of testing barometers, thermometers, and chronometers which had been carried out there previously was not transferred to Teddington until some years later. The immediate preoccupations of Glazebrook and the small band of assistants he had gathered round him were the establishment of a more accurate thermometric scale and the determination of the electrical units to a high degree of accuracy. In 1903 C. C. Paterson joined the staff to take charge of the electrotechnical work, and it was he who established what has now become the photomteric section of the laboratory.

Until 1906 all the work at Teddington was carried out in Bushey House. This was a large, rather rambling structure belonging to the Crown and situated in a corner of Bushey Park.

The last residents had been William IV when Duke of Clarence and Mrs. Jordan, and a great deal of work was needed to convert the building to serve partly as a laboratory and partly as the director's official residence, an arrangement which still persists. In 1906 a new building was added to accommodate the rapidly growing needs of Paterson's section of the work, and it was here that he carried out the investigations which led to the international agreement of 1909 on the unit of candle-power. Similar agreement on the electrical units had been achieved in the previous year, largely as the result of the work of F. E. Smith, one of Glazebrook's original team.

After 1906 the continued expansion of the work of the laboratory led to the erection, one after the other, of buildings for housing different sections. In particular, new buildings were put up for mechanical engineering, metrology, and metallurgy, and the Froude tank building for experimental work on ship design was given to the nation by Sir Alfred Yarrow and was opened in 1911. In 1909 the laboratory was asked by Lord Haldane to make arrangements for carrying out research in aeronautics, and this division now occupies more building accommodation than any other. A new administration building was opened by A. J. Balfour in 1913 and other buildings were added subsequently, especially to accommodate the vast extension of work of the metrology division during the 1914-18 war. A new building devoted entirely to photometry and illumination research was opened in 1936.

Until 1918 financial responsibility for the laboratory was taken by the Royal Society, who administered a grant-in-aid provided by the Government as a contribution towards the cost of the work, but the expansion which had taken place, especially during the war year, made the continuance of such an arrangement impossible, and in 1918 financial control was transferred to the Department of Scientific and Industrial Research, which had been created in 1915.

Lighting on the M.V. Oslofjord

The dining room.

The Oslofjord has been built to continue the ferry service between Oslo and New York at a service speed of 20 knots. There is accommodation for 226 first-class and 350 tourist-class passengers.

This passenger liner takes the place of a previous vessel of the same name lost in the war. Four years were spent on the design, 40 years of route experience have been incorporated, and the next 25 years have been anticipated in the requirements catered for.

In the cabin-class lounge and also in the dining-room. G.E.C. cold cathode lighting has been specially chosen to emphasise the decorative architecture, a feature of which in the dining saloon is a carved frieze illustrating Norwegian fauna and exemplifying Norwegian heraldic designs. Gold and ivory tubing has been used for this purpose, the A.C. supply being derived from a special generator set.

In the lounge the ivory and gold tubes are separately switched for colour effects and for blending with the tungsten fittings when the space is used for dancing.

The indirect cold cathode lighting was installed to the requirements of the decorative architect, J. A. Van Tienhoven, who also designed the lighting on the M.V. Oranje.

The maiden voyage of a new vessel is usually an event of note. The first transatlantic crossing of the 16,500-ton Norwegian - American Line's Oslofjord was an international occasion of European co-operation at its best.

A view of the main lounge. Cold cathode lighting was chosen to enhance the decorative architecture.

Shop Window and Display Lighting

By JOHN K. FRISBY,
*Registered Lighting Engineer (I.E.S.)**

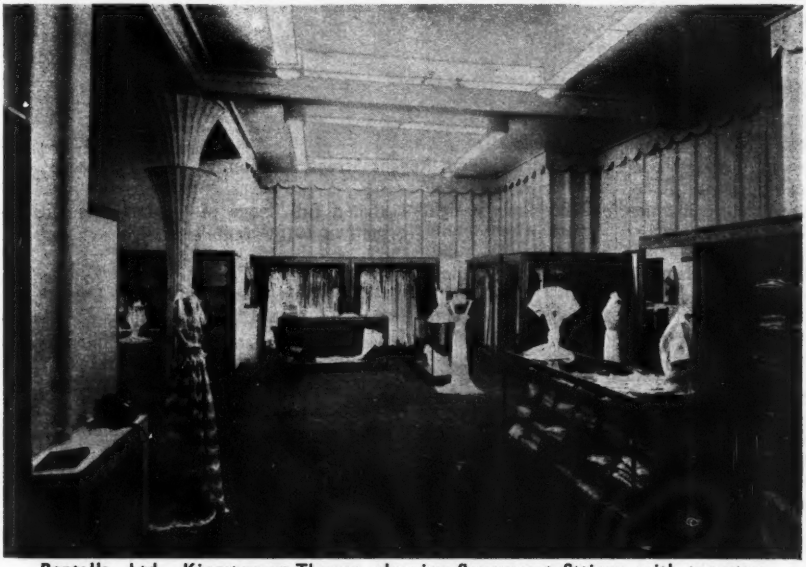
In this article an attempt is made to suggest how shop windows may be lighted in a pleasing way without excessive cost.

From the layman's point of view there is quite a lot of sense in the often-heard remark that ". . . . of course, shop window lighting is like stage lighting, and should be equally dramatic and flexible." There is, however, quite a lot of nonsense in it, as is realised when an attempt is made actually to apply stage lighting technique to a window. The theory of similarity may invariably be shaken by inquiry how a stage would be lighted if it were built in the centre of an auditorium with the audience all round it.

Yet that, in effect, is more often than not the problem which confronts the lighting engineer engaged in shop window lighting, for the normal customer's point of view is from two, three, or even four sides of the window. Furthermore, shop windows vary in size and shape to a much greater extent than theatre stages, and the different methods of display are almost unlimited.

For this very reason, if for no other, it seems hardly possible to evolve a formula which would guarantee ideal window lighting under all conditions. It is possible, however, to establish certain fundamentals which should be observed when planning window lighting; but this is merely a beginning. The nature of the merchandise, the type of window-dressing, the requirements of the display-man, and the personal taste and opinion of the store management all serve to complicate the issue. In fact, shop window lighting is almost as personal to each individual shop as is the colour scheme and

* The British Thomson-Houston Co., Ltd.



Bentalls, Ltd., Kingston-on-Thames, showing fluorescent fittings, with tungsten filament spotlights.

decoration of the lounge or dining-room of a private residence.

This article, therefore, will do no more than try to suggest how shop windows may be lighted in a pleasing way without excessive cost and without inflicting visual discomfort and distraction on customers; and to try to give some ideas on how to deal with the difficult windows, the special problems which are always arising, rather than to try to lay down a technique for the few straightforward jobs.

Richards' Shop, Regent Street, London.

Some Fundamentals of Good Window Lighting

(a) *The displayed merchandise must be the brightest area within the normal field of view.*

As the lamp which gives the light must always be brighter than the surface or object on which the light falls, this is really another way of saying that the lamp must be screened from view so that it does not distract attention from the goods.

(b) *Brightness variation is better than flat, even illumination.*

Highlights and shadows may be used to dramatise many window displays to great advantage, and directional lighting is important to emphasise shape, form, and texture, particularly in the case of garment displays.

(c) *Avoid glare due to images of light sources appearing in mirrored displays or backgrounds.*

Displays are often completely spoiled because specular objects, such as glass-topped tables, are placed in such a position that a full image of the lamps is mirrored in their surfaces.

(d) *Make use of colour contrast to dramatise displays.*

Colour filters or coloured lamps may be used to great advantage to intensify the colour of displayed merchandise, or to provide a contrasting background.

(e) *Provide adequate illumination at all times suitable to the location of the shop.*

Shops in main thoroughfares with good street lighting and cinemas, etc., with external lighting require much more light to be equally as effective as the small shop in a less brightly lit area. Furthermore, displayed merchandise which is dark in colour requires much more light than goods in pale

shades. This should be remembered when windows are being dressed.

(f) *The lighting should be sufficiently flexible to cater for the needs of all the different types of display.*

Novelty and change in display technique have the power to compel attention when ordinary window-displays are passed by. The lighting must be sufficiently flexible to make the most of all display methods.

Application of Lighting Principles

Let us now take these fundamental principles in turn and consider the technique necessary in each case to ensure that the requirements are met.

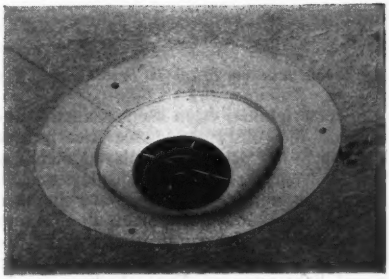
(a) *The displayed merchandise must be the brightest area within the normal field of view.*

We all know the compelling attraction of sheer brightness. We therefore concentrate on making the show window much brighter than its surroundings by planning for high levels of illumination. If, however, potential customers are attracted to a window by its brightness and then, when there, the attention is distracted from the goods by the even higher brightness levels of exposed light sources, the use of light defeats, in part, its own object. All lamps *must*, therefore, be screened from view by pelmet boards or louvres of some sort. Solid louvres, preferably in a neutral colour, are better than diffusing screens of frosted glass or plastic. The latter are still distractingly bright.

With windows having opaque back and sides the light sources, either fluorescent or tungsten, may be mounted behind the pelmet well out of sight. If the window is more than about 6 ft. deep, it is desirable to have another row of lamps about half-way back; this can be concealed by a pelmet board or artificial "beam" across the ceiling—such a feature does not distract attention, and is hardly noticeable if finished in the same colour as the ceiling.

However, in my experience, it is not this kind of window, but those glazed on two or three sides that seem to abound. These present a more difficult, but by no means insurmountable, problem.

Possibly the best answer for high intensity general lighting is to instal a complete louvred ceiling. This may take the form of "egg-box" louvring, circular rings or honeycomb shapes or any other form that personal taste demands. Furthermore, the colour can vary almost from black to white



Spotlight reflector fitting.

but the darker the colour the more lamps are required for a given illumination on the merchandise. Pastel shades are probably best of all and some very pretty effects can be obtained by using colours sufficiently strong to subdue the brightness of the ceiling and harmonise with the display. Fluorescent lamps are best above a louvred ceiling for the general lighting and, in order to get even brightness on the louvres, should not be farther apart than their distance above the top of the louvres. Highlighting may be carried out by reflector spot-lamps, and if quite a number of these are installed on separate switches they can be used when and where required. The corners of a louvred ceiling may be blanked off and adjustable flush mounting spot-lamp units installed to cater for directional lighting requirements.

In cases where the scheme described above would be too expensive, good lighting can still be achieved by using louvres over only parts of the window. Attractive patterns may be formed by flush rectangles or squares in the soffit above which fluorescent lamps are mounted. Circular apertures of the porthole type, having concentric rings, provide the high-lighting and promote sparkle on cut-glass, jewellery, etc., and directional lighting is obtained by spot-lamps in adjustable housings. When these are attractive in appearance it does not matter if the whole ceiling is visible from outside.

For good lighting in windows in which the whole ceiling is visible, it is really necessary to have a false soffit so that lighting equipment can be recessed. Nevertheless, there are, of course, times when this is not possible and the only answer then is to use multi-lamp laylights having "egg-box" louvres below the lamps. If the louvres are finished in a dark colour the fittings are not obtrusive at night and good design will

result in quite a pleasing daytime appearance.

(b) *Brightness variation is better than flat, even illumination.*

Sheer brightness is, in itself, attractive and enables the observer to see clearly and accurately the detail of displayed merchandise. Nevertheless, many displays require more than simple, straightforward illumination—they need to be dramatised. Texture, shape and form are all improved by the addition of emphasis lighting from directional light sources. Even shadows can be desirable in a window, providing these fall on a plain background and not across some other item of the display.

From the foregoing it will be seen that, generally speaking, a combination of fluorescent lamps, which give an even, general illumination, and tungsten filament lamps giving directional lighting will probably provide the most satisfactory lighting conditions in the display window; the proportion of the two light sources will vary according to the merchandise displayed.

For instance, jewellers' windows can do with more tungsten lamps than fluorescent—or even tungsten alone—because of the sparkle that the image of a high-brightness filament promotes in the precious stones. Furniture windows may be improved in appearance by the warmth and atmosphere of tungsten lighting, although fluorescent lamps are necessary for the accurate colour rendering of carpets and curtains, etc. Shoe shop windows can be lighted successfully with fluorescent lamps alone, but it is desirable to have some tungsten lamps in windows given over to stocking displays as the sheen on the silk is thus enhanced.

As a general rule, although there are exceptions, windows given over to the mass display of quantities of smallish articles, where all are required to be seen clearly without the interference of shadows, can be illuminated by fluorescent lamps alone. Large single articles such as coats displayed on models, furniture, etc., can have fluorescent lighting for a general background with each item in the window high-lighted by directional tungsten spots.

(c) *Avoid glare due to images of light sources appearing in displays or backgrounds.*

Mirrors on the walls of a display window, especially in furniture displays, can be very helpful by increasing the apparent size of the window and showing views of the otherwise hidden sides of the displayed merchandise. It is most important, however, that such mirrors be very carefully placed so that images of the light sources cannot be seen. Displays which are otherwise excellent can be completely ruined by the glare from such images. Overhead lighting, even through louvres, often provides an almost unbearable image in a glass-topped table but an alteration in the angle of the reflecting surface of only a few degrees will often avoid such trouble.

(d) *Make use of colour and colour contrasts to dramatise displays.*

Colour contrast to attract attention is just as valuable as brightness contrast. Pigments are used by display men for this purpose to a much greater extent than lighting and yet colour provided by lamps is far more alive and far easier to apply than pigments can possibly be. Neutral backgrounds can be flooded with, say, green light one day for a given display and with pink light the next when the display is changed. No paintwork is necessary—simply the changing of a lamp.

The best lamp for background lighting is, of course, the fluorescent lamp, which is available in a range of colours.

Apart from the use of colour to promote effective contrast, tinted lamps or lamps with colour filters can be a great help in enhancing the appearance of certain merchandise. (The well-known example is the use of pinkish lighting for the display of fresh meat.) Colours of garments may be made more vivid by using a reflector spotlamp with a filter of the right colour. For example, pink or red garments shown under fluorescent lighting look much richer and warmer if they have a small amount of filtered light of a warm tone added. This, of course, should not be so strong as to overemphasise or distort the effect.

(e) *Provide adequate illumination at all times suitable to the location of the shop.*

Good lighting causes a shop window to stand out and attract attention due to its contrast with the surroundings. The greater the contrast the more effective is the window in compelling attention. A single illuminated shop-window, standing by itself in a dark street, has the greatest possible advantage, and need not have a high intensity of illumination, 25 lumens/sq. ft. being adequate, whereas a window in a main shopping thoroughfare with good street lighting, cinemas and neighbouring shops might need as much as 250 lumens/sq. ft. to be equally effective.

However, it must be remembered that it

is not the *illumination* that is the deciding factor, but the *brightness* of the merchandise. As the brightness of a surface is the product of the illumination and the reflection factor, the lighter the colour of the displayed goods the less illumination is required for a given effect. For example, if 70 lumens/sq. ft. is considered desirable for a display of tweeds having a r.f. of about 35 per cent., only 35 lumens/sq. ft. would be required for a display of cotton goods having a r.f. of 70 per cent. The amount of lighting installed should cater for the darker goods, and then some current can be saved by switching out certain lamps when light-coloured goods are displayed.

It is often said that daylight reflection can be avoided in the window glass by illuminating the window during daytime. This is true, but the amount of light required is such as to make it hardly an economical proposition, since, for instance, an illumination value of the order of 1,000 lumens/sq. ft. is desirable to overcome images on a bright day.

(f) *The lighting should be sufficiently flexible to cater for the needs of all the different types of display.*

Display personnel go to a great deal of trouble in changing completely the interior of the window at frequent intervals. The floor-covering, backgrounds and colour schemes are varied, and the arrangement of the merchandise and even the very nature of the goods themselves are altered completely; all to provide something new for the public to look at. Yet how often is the lighting scheme changed? Comparatively rarely, because it would mean a job for the electrician in most cases if the positions of the equipment have to be altered. How much better it would be if the lighting installation were sufficiently comprehensive and flexible in the first place to provide a wide variety of effects simply by different switching.

With real flexibility the display-man can give himself silhouette effects, coloured backgrounds and spotlighting, high-intensity general lighting in natural daylight quality, soft general lighting in colour, and feature lighting with adjustable spots. All these and combinations of these should be possible, together with electrical outlets for luminous signs, flourescent effects and animated displays. The lighting would then be worthy of the best product of the display man's art.

Conclusion

The subject of installation design in windows is too vast and too detailed to cover in one article, or even a series of articles, and, as was shown at the beginning, it is hardly possible to reduce window-lighting technique to a simple foolproof formula. The points elaborated above may, however, be summed up as follows:—Observe the fundamental principles and then apply imagination, common sense and good taste; these, together with an intimate knowledge of the type of merchandise and the method of display in the window under consideration will invariably achieve a result far more effective than any standardised calculations could possibly produce.

A Photometric Cell for Accurate Photometric Measurements

Progress in the development of emission type photocells is indicated by the recent introduction by Mullard Electronic Products, Ltd., of their photometric cell type 57CV. This cell, which is of the vacuum type, has a specially prepared cathode of caesium-on-oxidised-silver, and is intended for use in circuits designed for making accurate photometric measurements in the red and infra-red region of the spectrum.

In order to obtain the best possible linearity between current and illumination, a flat, double-sided cathode is employed, surrounded by a gauze anode. Leakage between anode and cathode is reduced to a minimum by the use of a top connector for the anode and by the provision of a guard ring in the anode-to-cathode leakage path within the tube. The projection area of the cathode is 4.5 sq. cm. on each side.

The sensitivity of the new cell, measured with a lamp of colour temperature 2,700 deg. K at 0.1 lumen with total area of one side of the cathode illuminated, is 25 uA per lumen. Other characteristics of the cell are as follows:—

Dark current at 100v. (max.) 10^{-4} uA
Anode supply voltage 100v.
Cathode current (each side) 5 uA

The 57CV is fitted with a standard British four-pin base.

Lighting Shop Interiors

By R. L. C. TATE*

Lighting for display extends beyond the shop window into the interior where the goods are sold. The following article discusses some of the points to be watched in designing the lighting for shop interiors.

Lighting for display does not stop at the shop window. It must continue inside the shop, too, but here it will be modified by two other important factors, viz., the achievement of a good selling atmosphere, and provision of lighting of suitable quantity, quality, and colour for the close appraisal of goods by customers. It was formerly the practice to provide high even illumination by means of general lighting in every type of shop; it is now realised that except in the cheap multiple stores, where all goods are laid out on trays and customers are free to turn them over and examine them at will, a general lighting system provided by evenly-spaced rows of fittings is not always the best. Perhaps the present winter restriction to 1½ watts per square foot has also contributed to a change of mind, as it has made it necessary to consider how to put the small wattage available to the best effect.

Intensity of Illumination

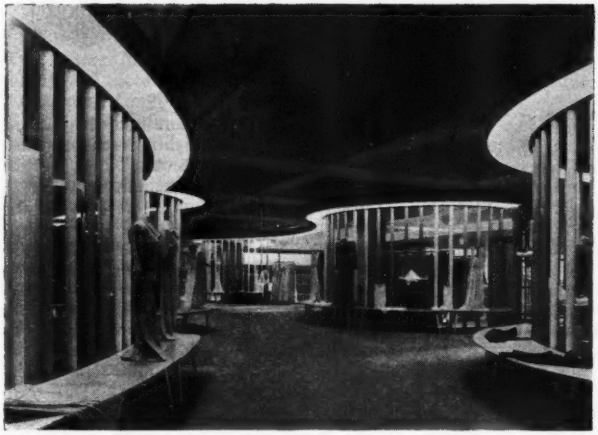
Although a high value of general illumination is not usually recommended in the better-class stores, exception must be made in the case of ground-floor departments which open directly on to the street. Customers entering from bright sunlight will experience a feeling of gloom if the lighting is of too low an intensity, so that these areas are normally lit to a rather higher level than the rest of the store. On the upper floors it is often advisable to lower the intensity of the general lighting in order to give the maximum value to the lighting on special displays. The method of achieving a high overall brightness depends a great deal on the height and nature of the ceiling. If the latter is much broken up by beams, luminous troughs along their edges may be found very satisfactory, whilst a plain, flat ceiling may have to be lighted by means of louvred fittings arranged in rows. If this is done, careful consideration should be given as to whether the fittings should present an end or side view to the customer looking down the shop. Sometimes fittings with reeded "Perspex" or ribbed glass sides are rather too bright to be mounted in the latter position: where the sides of the fittings are opaque it makes little difference which way round they are mounted.

Fluorescent general lighting, following the structural lines of the ceiling, gives a high intensity over the ground floor of this large tailoring shop. The light matches well with natural daylight from the window at the back.

Distribution of Light

It is a sound rule, where the better-class shops are concerned, to concentrate the light on counters and display areas rather than to provide an even illumination over the whole floor area. A general lighting scheme, where fittings hang in the centre of ceiling-

* Lighting Service Bureau, London.



Concentration of light on the display is the main feature of this installation where the louvred troughs also serve to assist the customer through the department. Note, too, the lighted showcases at the back of the shop.

panels, will frequently serve chiefly to light the floor space between counters, while customers stand in their own light as they examine the goods. The lighting scheme, therefore, should be planned with more regard to the position of counters and showcases than the decoration of the ceiling. If sufficient light is put on the display quite enough will usually spill on to the floor area, and for some types of display it may even be necessary to keep the general lighting of the room low in order to emphasise the lighted displays. In addition, lighting can be used in large stores to control, or even to initiate, the movements of customers from one part to another, and in this connection both lighted features, such as lines of light on walls and ceilings and brightly-lighted display areas sited to assist the flow of traffic, are often used.

Open-backed Windows

Many shops are now being designed with open-backed windows, and where this is done there is no doubt that the lighting must be made to display the interior of the shop to passers-by. The provision of lighting, which is not only attractive when seen from the street but also comfortable for customers inside the shop, is not by any means easy, and there have been a number of attempts to solve this problem in the past year.

It should be remembered that, except in the case of travel bureaux and some purely "prestige" installations, proper window lighting must be installed and at the same time customers must not be blinded with glaring window-lighting reflectors shining in their faces. The use of sections of louvred ceiling over the window area and entrance to the shop is a possible solution, particularly where fluorescent lamps are to be used. In order to obtain a reasonably even brightness of such a section rather close spacing of lamps may be necessary, particularly if there is not much space between the louvre grid and the ceiling. A number of shops using this type of window have overcome the difficulty by using intensive reflectors or shop window spot-lamps in louvred fittings mounted directly above the display; another very simple solution is to install a secondary pelmet inside the window.

Lighted Counters

Lighted display counters have long been a feature of our large stores, but there now seems to be a tendency to swing away from the internally lighted glass-topped counter. Where counter showcases are lighted from within the front only is glazed, the top of the showcase being made of some opaque material and lighted from above. The object of this technique is two-fold: first, to provide concealment for the lighting equipment, which is difficult where no wooden or metal framing is provided; and, second, to avoid objects displayed on the top of the counter being seen in silhouette against its lighted interior.

Another method which is gradually coming into use in this country is to light an all-glass counter by means of spotlamps recessed in the ceiling above it. Care must be taken to site the lamps to avoid reflections in the top of the counter, and it is

important to consider also the comfort of sales-staff, who should not be subjected to either the direct or reflected glare of a battery of lamps.

Lighted Features

The tendency nowadays is to substitute lighted alcoves and framed recesses for the projecting type of glass showcase, and they are found to be much easier to light since it is far simpler to conceal the lamps. Generally an alcove would be lit by two or more fluorescent lamps concealed behind baffles on either side, though sometimes more elaborate methods are used. Where the projecting type of glass showcase has been relighted with fluorescent lamps it is very common to see the latter mounted vertically in the angles of the glass, completely unscreened. This practice is much to be deprecated as the glare from the lamps is most unpleasant and not only attracts attention away from the display but can ruin the effect of an otherwise pleasant interior.

Backgrounds

The colour of backgrounds of display alcoves or cabinets is an important point as it can affect both the apparent colour of the goods displayed and the general atmosphere of the shop. Red or pink goods, for example, should be shown against a pale blue or green background, as by this means maximum colour contrast is obtained. Seen against a red or pink background they will appear far less striking. A pale blue background lighted by means of "natural" or "daylight" fluorescent lamps will give the effect of a sunny summer sky and provide a good selling atmosphere for outdoor clothes or sports goods.

Atmosphere

"Atmosphere" in a store is of the greatest importance, and the lighting scheme must always take it into account. A practice which is becoming increasingly common is to use fluorescent lighting to provide the main illumination in a room and filament lamps in decorative fittings to provide atmosphere. The fluorescent lighting is generally concealed, but installations of this nature where the lamps are merely mounted behind obscuring glass are not uncommon. The filament lamps in such cases are generally of low wattage and are mounted in decorative metal or glass candelabra. This technique is by no means confined to luxury shops in the Bond-street area: it can be seen in a number of comparatively inexpensive installations elsewhere. It is especially useful where rooms are decorated in a "period" style where pendant fluorescent fittings would look out of place and it is impossible to provide sufficient light by means of the appropriate "period" fitting.

Special Displays

Especially in large departmental stores there is a tendency to use special displays so sited as to assist traffic-flow, to attract customers into outlying departments, etc. These displays are nearly always lighted to a higher intensity than the rest of the room and in the most up-to-date installations special lighting is installed for this purpose.

Filament lamps in painted fittings with brightly-coloured parchment shades give colour and life to this conventional fluorescent installation.

Where the general lighting is provided by fluorescent lamps, filament spotlamps are very useful for providing this accented lighting: where filament lamps are generally used, an alcove brightly illuminated by fluorescent lamps is particularly striking. The type of light-source used may depend upon the goods displayed: a display of red materials glowing richly in the light from filament spotlamps will stand out well in a fluorescent lighted shop, while blues, greens and yellows will look more effective under fluorescent lighting. Methods of concealment of lamps vary considerably: simple pelmets, lamps recessed in false ceilings, and quite elaborate louvred grids are all commonly to be found. The siting of such features is quite important and must be carefully considered when the interior layout is being considered. A lighted feature too near a door, for example, may increase congestion at an already crowded point, whereas one at the end of a gangway will attract people in that direction and be far more effective as a display. The effectiveness of such a feature depends largely upon the level of general lighting: where the latter is high, individually lighted displays lose much of their force.

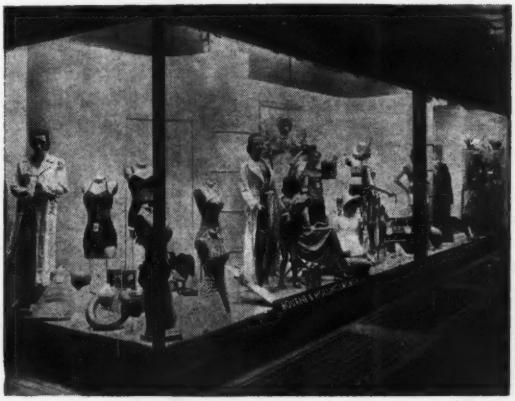
Future Possibilities

The indications are that in the store of the future more and more attention will be paid to lighting. In every really striking new interior, lighting is the most important factor. It seems likely that the open-front technique, many examples of which are to be seen, will become more popular in the future, though in large stores it is likely to be confined to the entrance vestibules. In many instances, the windows surrounding the entrances are becoming mere showcases whose line is continued through the clear glass doors; the use of lines of luminous features drawing the customer into the shop seems likely to become even more popular in the future than it has been in the past.

Window Lighting in an Oxford Street Store

All the display windows at Messrs. Bourne and Hollingsworth, Ltd., Oxford-street, have been equipped with new lighting using a combination of Osram cold cathode tubes and tungsten lamps.

The window illustrated, in Berners-street, was the first to be completed and is representative of the principles that were followed throughout. Intermediate white cold cathode tubing, made up in units each with approximately 20 ft. of tube bent in a double hairpin formation, is mounted lengthwise in the centre of the window. The units are spaced approximately 2 ft. apart. The tungsten lighting is provided by two rows of Osram 150-watt lamps in silvered glass reflectors at the front and rear of the window. Contractors for the whole installation are Messrs. Barlow Bros. and Co., 110, Drury-lane, W.C.2.



One of the windows at Bourne and Hollingsworth's, Oxford Street, equipped with a combination of cold cathode fluorescent and tungsten lighting.

Fig. 1. Plan showing layout of showcases.

Lighting in a Dress Shop

Richards' Shop: new premises in Regent Street

When Richards' shop premises in Regent-street were designed, there was still a complete ban on shop-window lighting. The fact that the window on the left-hand side of the entrance is both part of the inside sales area as well as a window, enabled the window display to be illuminated by the normal shop lighting. The front part of the shop has been designed to bring the sales area forward and yet at the same time to present an attractive display to the passer-by.

The lay-out of the shop will be seen from the plan which, together with the photographs, will enable the reader to form an impression of the interior of this unusual and attractive shop.

The main part of the shop is at the rear.

Fig. 2. A view of the rear part of the shop showing the false soffit and the louvred laylight.

In this section the whole stock of clothing is displayed either in standard wall fixtures or on movable racks, the wall fixtures being lighted by fluorescent lamps from immediately above. A suspended ceiling hangs 13 ft. 9 in. above the floor, and in this is cut an irregular-shaped opening (see dotted line on plan) to expose the ceiling, which is lighted indirectly by means of 5 ft. fluorescent lamps supported and concealed by false bars spanning the opening. At the back of the shop (see figs. 2 and 3) is a curved lay-

Fig. 3. A view of the dress salon in the other direction showing indirect lighting over the display in the far corner, spotlight fittings and recessed wall displays.

light screened off by aluminium louvres which hide the unsightly glazing and reflect daylight into the room. These louvres are lit by fluorescent lamps concealed above the false ceiling, which ends just beyond the two pillars at that end of the shop. (See fig. 4.)

The lighting in the front of the shop is obtained from fluorescent tubes mounted in continuous troughs above the edge of the false ceiling. In addition, both in the front and rear parts of the shop, special lighting for display is obtained by the use of internally silvered reflector spot lamps in "eyeball" fittings recessed into the ceiling. All the fluorescent lamps are of the "natural" colour. The full lighting load is 18 kw., being approximately equally divided between fluorescent and the incandescent spotlights.

The architects were Bronek Katz and R. Vaughan.

Fig. 4. (*Above.*) Showing the louvres screening the curved laylight.

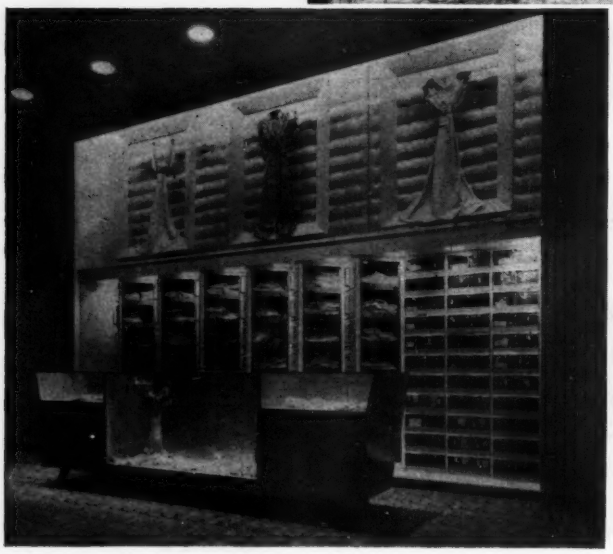


Fig. 5. Wall displays lit with fluorescent lamps concealed from view by the false ceiling in which are recessed reflector spotlights providing lighting on the counter.

Lighting in a New Store

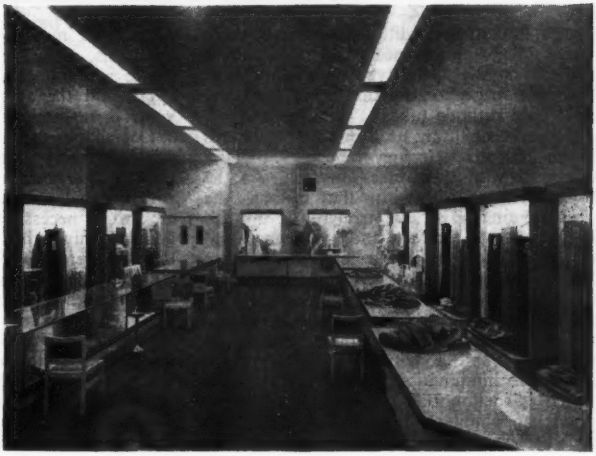
All departments in the new store of Messrs. T. B. and W. Cockayne, Ltd., Sheffield, have been equipped with Osram cold cathode lighting, using G.E.C. fittings specially modified for this installation and fixed flush with the ceiling. Extensive use has been made of G.E.C. fluorescent fittings and Gecoray reflectors for window lighting.

There was a Cockayne's store in Angel-street, Sheffield, continuously from 1829 until the night of December 12-13, 1940, when the premises were completely

Lighting in two of the departments of Messrs. T. B. and W. Cockayne, Ltd., Sheffield, with cold cathode lighting in flush ceiling fittings with louvres.

(Above). The Fancy Goods Department.

(Below). The Fabric Department.



destroyed in an air raid. In its new building the store has returned from temporary premises to its historic site, where over 100 years ago its founders established their business of "Linen and Woollen Drapers, Silk Mercers and Hosiers." Two floors of the new building have been opened so far, but the final design incorporates five or six. The architects are Messrs. J. W. Beaumont and Sons, Manchester.

When lighting for the new premises was being considered, a demonstration of tungsten and various colours of fluorescent lamps, both hot and cold cathode, to give an illumination of 50 ft. candles on specimen goods, was arranged. After representatives of Messrs. Cockayne, including the firm's buyers, had examined many classes of goods in these conditions and had compared their appearance with that under ordinary sunlight, the type of lighting most favoured was a combination of daylight and gold cold cathode tubes.

Fittings used are industrial trough reflectors specially equipped with transverse louvres.

The type of fitting used in all departments is an industrial trough reflector specially equipped with transverse louvres. As the fittings are flush with the ceiling, the aperture on top of the trough for upward lighting is not required and has been sealed up. The use of transverse louvres alone has been found to reduce the surface brightness from normal angles of view quite sufficiently. At the same time the light available is not reduced as much as it would be if both transverse and longitudinal louvres were used; also illumination in the vertical plane, which is so important in the display of the goods on counters, etc., is not affected as much. The shielding of the tubes from view is particularly effective when rows of fittings are seen end on, as when entering the store. A very pleasing effect results from the ceiling lighting in combination with the upward light provided in the showcases by Messrs. E. Pollard and Co., Ltd.

The rows of fittings are 12 ft. apart on average, and the fittings themselves are mostly at 11 ft. 6 in. centres. Each is responsible for lighting an area of 132 sq. ft., and contains one gold and two daylight tubes. The spacing and arrangement of the fittings was governed to some extent by the fire sprinkler system and constructional features in the ceiling, so that the layout is subject to modifications here and there, but the principle has been followed throughout of arranging the rows of fittings on the customer's side of the counters in order to obtain the most advantageous illumination of goods. The mounting height is 13 ft. There are 166 ceiling fittings in all in the store, and the average service illumination value is 18 lumens per sq. ft.

Detachable panels in the ceiling between adjacent fittings can be removed for maintenance purposes, enabling fittings to be disconnected and taken down for cleaning etc., when necessary. All this work can be done through the panels from below, so that the removal of a fitting and the substitution of a clean unit can be accomplished rapidly with the minimum of interruption to the business of the store.

The G.E.C. also supplied 31 four-lamp fluorescent shop window fittings. In all windows where they are used they are supplemented by two Gecoray reflectors with 200-watt tungsten lamps for highlighting selected features of the display.

Fig. 1. General view of island showcases at Coad's of Kingston.

The Louvre Applied to Shop Window Lighting

By E. R. HARRISON-JONES*

Louvred fittings are commonly used in this country, but louvred ceilings are less frequently seen. This article deals with the application of the louvred ceiling to windows only.

We in this country, unlike our friends across the Atlantic, have not used the louvre to any great extent—that is, the louvre en masse, constituting a complete false ceiling. The apparent reason for this lack of development is that the louvre is essentially a high foot candle device, having had little application in the commercial interior. Although very effective, it is also definitely limited in use, bearing in mind the interpretation of "high" that has to be made by the lighting engineer in connection with the average commercial interior in this country.

However, when we come to shop-window lighting the story is quite a different one, for not only are the higher values of illumination more likely to make the louvre economically justifiable, but the system is also desirable, if not essential, for creating acceptable brightness ratios in installations which may be providing anything above 50 ft.c.

Generally, the most important aim in lighting the windows of the average shop is a standard of general illumination consistent with the district factor, together with supplementary accent lighting from "spots" as required. To cope with increasing standards of general illumination the use of high efficiency hot cathode fluorescent equipment is becoming general. Even so, the disposal of the necessary lighting units becomes a considerable problem, particularly where existing window construction has to be used, with no chance of flush-fitting the units into the ceiling.

In the majority of cases the lighting engineer has to follow the actual window line, placing the equipment as close to the window as possible. If he is lucky he will be able to mask the units against an opaque pelmet, although he may have the misfortune to be dealing with a translucent pelmet. In any event, with a deep return window the lighting fittings are still too much in evidence.

Under certain conditions, an arrangement using fittings in the manner just described can be termed good lighting practice, providing that one is prepared to accept the aesthetic disadvantages of the system. From the lighting point of view, however, the

* Thorn Electrical Industries, Ltd.

problem is frequently not so much one of aesthetics as one of brightness, and the theme that the lighting installation which fails on brightness also fails in its function of providing good seeing conditions is especially true of shop-window lighting.

The louvre as a suspended sub-ceiling overcomes brightness problems, allows the lighting engineer to position equipment with due regard to efficiency and effect without having to consider appearance, and permits really good standards of illumination with very comfortable seeing conditions. The louvre is also particularly useful in getting the rear areas of deep windows adequately illuminated, e.g., in the average gown shop where obstruction difficulties may be encountered. An example of the louvre applied to this type of installation is indicated in Fig. 3, the 100-hour value here being about 50 ft.c. at floor level. The visual effect is extremely comfortable and an interesting point is the shadow factor giving good modelling whilst bringing out the material texture. These results are due to the sources being above the vertical surfaces of the gowns, for with the fluorescent source concentrated at the edge of the window the general direction of the light would be very much more normal to the vertical gowns, therefore tending to introduce the "flat" effect which has been the subject of much criticism of installations of this type. Cell size in this particular case was a 3-in. cube having a weight of 3.3 lbs. per sq. ft. The system was built up from 3 ft. × 3 ft. panels, representing a convenient panel weight for handling on site.

Some electrical contractors and a number of larger users have constructed their own louvre systems for shop-window lighting on site, the usual materials being hardboard or plywood, these being easier to work than metal. Because of the thickness of the material and also no doubt, to simplify construction, cell size is usually large; if the necessary depth above the lower edge of the louvre is available, a 6-in. cube is common.

Fig. 1 is a general view of the lighting treatment for island showcases using a 6-in. × 8-in. cell, the illumination values here being about 30 ft.c. at floor level, with about 60 ft.c. at 3 ft. level.

The comparatively easy manner with which, for instance, hardboard can be worked makes a departure from the usual straight lower edge of the louvre practical, and a good example of this is shown in Fig. 2, a detail of the scheme illustrated in Fig. 1 where it can be seen that two sides of the lower cell edge are slightly concave in form.

The illustrations also show how effectively the island window problem can be solved by

Fig. 2. A close view of one of the showcases shown in Fig. 1.

Fig. 3. An example of the application of louvres to deep windows.

the louvre system, allowing for all sides of the island to be viewed without discomfort glare.

The most important advantage of the louvre is its ability to provide comfortable brightness conditions for really high standards of illumination. There are, however, other features. One is the masking advantages of the solid sub-ceiling, with very neat overall appearance, and another is the possibility of incorporating "spots" within the louvre when dealing with those of the larger cell construction.

There are also disadvantages, a serious one being maintenance, the multiplicity of surfaces, in spite of their vertical nature, presenting obvious difficulties; the larger cell certainly has easier maintenance in its favour.

Cost is another severe limitation for, quite apart from the metal louvre cost—which is bound to be comparatively high due to small production—the complete lighting system is rather expensive, because of the high illumination standards associated with the louvre.

The possibility of reflected glare troubles must also be mentioned, particularly where the display includes specular articles; this may, however, be desirable and cannot be completely condemned.

"Brightness engineering," although studied and applied in many instances in this country, is not yet general practice, due, no doubt, to the fact that our enforced standards of illumination do not make this aspect of illuminating engineering so vital. Even so, control of brightness, always one of the most difficult problems for the lighting engineer, is becoming of increasing importance.

The great amount of research carried out by the Americans on brightness problems, with the resultant change of approach from foot-candle to foot-lambert engineering, is undoubtedly related to their extensive use of the louvre in current practice.

Being one of the most effective ways of dealing with brightness difficulties, it is hoped that the louvre generally will receive wider consideration, particularly if we look forward to the improvement in our general standards of lighting which in spite of their great advances in recent years still leave much to be desired in many instances.

Acknowledgments are made to Messrs. Coads of Kingston, Ltd., Kingston-on-Thames, for permission to use Figs. 1 and 2 and the installation in this case was carried out by Messrs. W. T. Booth and Co., Ltd., Hampton Wick.

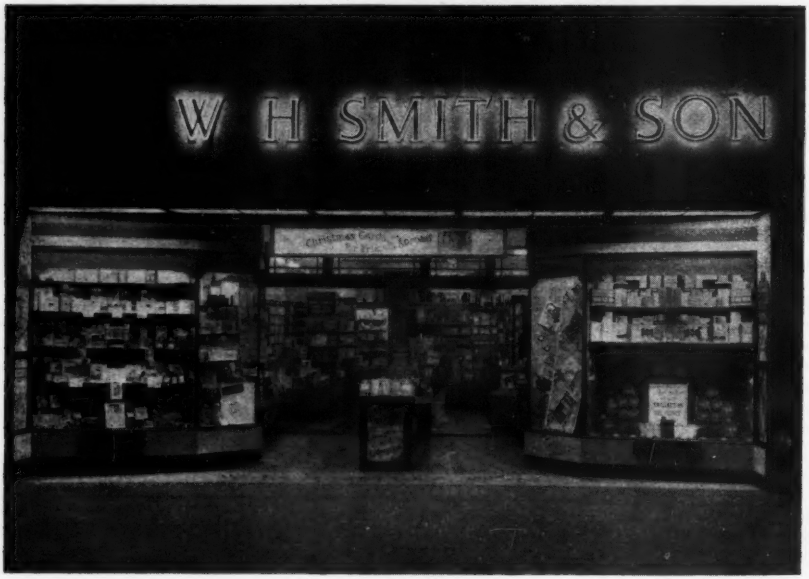
Acknowledgments are also made to Messrs. Martins, Ltd., E.3, for permission to use Fig. 3, the installation of which was carried out by Messrs. L. Power and Sons, Ltd., Ilford.

Lighting in a London Bookshop

This article describes the lighting in the Kingsway shop of W. H. Smith and Son, who are converting the lighting of all their shops from tungsten to fluorescent.

A fine example of modern shop lighting and the successful application of fluorescent lamps exists in Messrs. W. H. Smith and Son's premises in Kingsway. Situated in the heart of London, this bookshop, though by no means the largest of the W. H. Smith organisation, is one of its busiest.

The installation resulted from a series of tests initiated by Mr. W. G. Norris, L.R.I.B.A., the company's architect, in order to determine the value of fluorescent lighting for the company's many bookshops throughout the country. The interior lighting was first considered, but with the partial lifting of the new scheme was that the existing lighting points should, as far as possible, be retained, in order to avoid extensive rewiring or reconstruction. It was also desired to

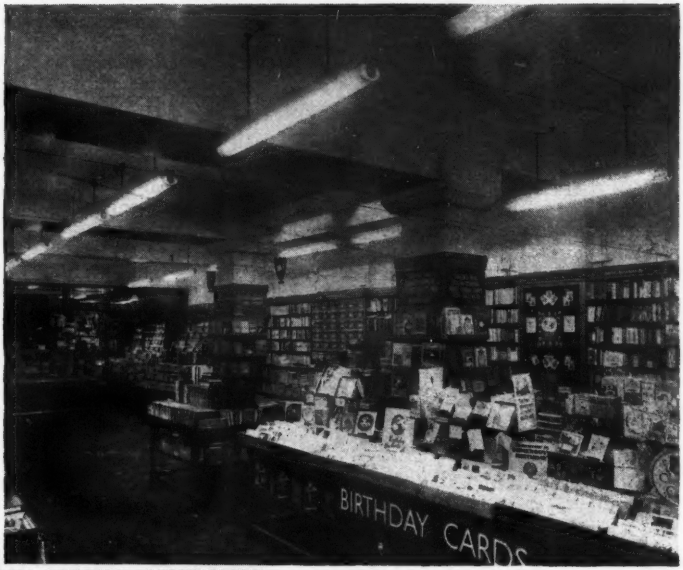


Shop front in Kingsway.

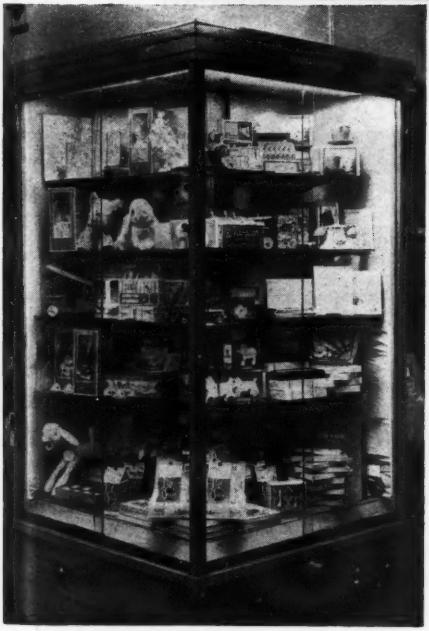
of lighting restrictions the tests were extended to local displays within the shop, to the entrance foyer, and to the shop windows. The success of the installation which was finally approved can be gauged from the impressive front view of the relighted premises shown in Fig. 1. The standards and methods established in Kingsway are now being applied throughout the entire W. H. Smith organisation.

A main consideration in the design create a pleasant atmosphere by means of lighting equipment harmonising with the general treatment of the shop. A lighting intensity of the order of 15/20 lm/sq.ft. was thought desirable, though the loading of the installation was not to exceed that of the existing scheme.

The new lighting layout was determined from considerations of the arrangement of display cases, counters, and wall fixings. The average spacing of fittings is 8 ft. x 10 ft.,



Interior of the shop looking towards the street.



One of the larger showcases.

and the mounting height 9 ft. 6 in. This height was selected so that no unsightly shadows would be cast by the ceiling beams. Single lamp, 80-watt fittings with "Warm White" lamps were used. The illumination after 300 hours' burning varied between 15 and 20 lm/sq. ft. in the shop and 30 lm/sq.ft. at the entrance. This is a great improvement on the old installation, in which the intensity varied between three and seven lm/sq.ft.

The selection of fittings is of considerable interest. Ease of installation and maintenance was essential, and a clean architectural form was particularly required. It was decided to use an 80-w. channel unit, with enclosed switch-started slim-line gear, together with a specially designed clip-on "Perspex" diffuser. The diffuser is approximately elliptical in cross-section and was designed not only to give a good upward component of light but also to ensure low fitting brightness. It is, in fact, largely due to these two factors that so successful an installation was achieved; not only is the ceiling illumination uniform, but the brightness contrasts throughout the shop are particularly pleasing. One is, in fact, left almost unaware of the light sources when viewing the shop.

The local display lighting embraces wall

fixtures, and both large and small showcases. For these resort was made to the 1-in. diameter 15-watt and 36-in 30-watt lamps which lend themselves to easy concealment. Fig. 3 shows one of the larger showcases. In every case the control gear was placed remote from the lamps, suitable facilities for concealment being available.

Very careful attention was given to the treatment of the entrance foyer. The daylighting at the entrance of the shop is particularly good and it was felt necessary to provide a graduation in the lighting from foyer to shop to prevent any possibility of discomfort when entering. An intensity of the order of 35 lm/sq.ft. was provided by soffit lighting, referred to again later, a figure of the order of 25 lm/sq.ft. in the foyer itself, falling, as indicated above, to somewhat over 15 lm./sq.ft. in the shop interior. This careful planning removed the sensation of discomfort which was noticeable with the old tungsten installation.

The window lighting presented a difficult problem as closely packed displays are invariably used. Various arrangements of lighting from the bottom, sides, centre, and top of the windows were considered but for various reasons it was decided to use top lighting only. The limited space available restricted the intensity which could be obtained by this means alone, and it was therefore decided to employ the unusual technique of additional soffit lighting in front of the windows, not only to illuminate the frontage, but also to supplement the local lighting of the windows themselves. By this means an intensity of at least 30 lm/sq.ft. was attained at all essential points of the window display. As will be seen from Fig. 1 the completed effect was outstanding.

All the lighting equipment was supplied by Messrs. Siemens Electric Lamps and Supplies, Limited, the installation work being carried out by Messrs. John Hearson and Co., Ltd., of Portsmouth-street, W.C.2.

The Lighting Service Bureau

at Savoy Hill, London, W.C.

The London L.S.B. has recently been refitted and is described below.

Those who have recently visited the E.L.M.A. Lighting Service Bureau will have noticed the alterations which have taken place over the last few months in the familiar demonstration rooms.

The first to be given the "new look" was the Architectural Lighting Room, and now the redecoration of the main demonstration room has been completed.

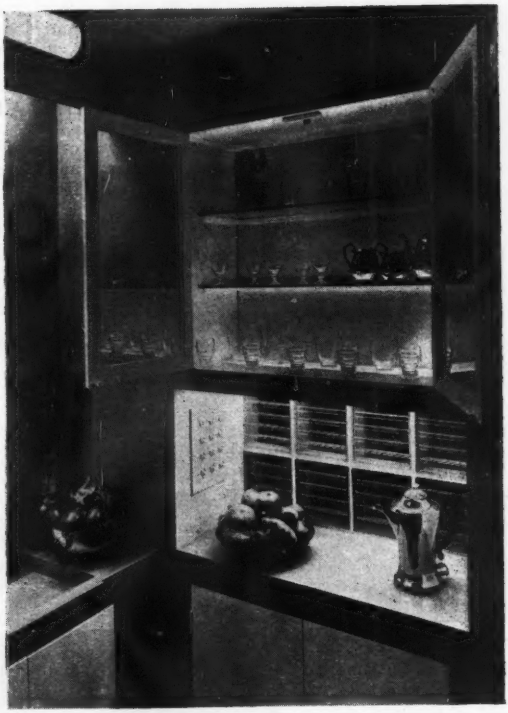
Here three ceiling treatments, including a striking two-colour section of louverall ceiling, cover the main body of the room, while the north wall now carries a comprehensive series of light and colour demonstrations which face the new domestic section.

It is this last which is now chiefly attracting the attention of visitors to the

Bureau, as it is an unusual departure from the normal sectionalised type of domestic lighting display. No effort has been made to put over ideas for specific localities, but different domestic lighting applications have been deliberately scattered so that each may be accepted on its merits and installed as best suits the circumstances of the individual. Colour, which, plays a large part in the success of this display, has been chosen to provide an equally good background for both filament and fluorescent lighting.

The majority of the lamps used in this section are fluorescent, and the results are so obviously successful that a number of people with preconceived ideas have already been converted to the view that wide adoption of fluorescent domestic lighting is now a practical certainty.

The Bureau, which is open from Monday to Friday, is well worth a visit. No appointment is necessary, but if information on any specific point is required it is as well to telephone Temple Bar 7337 first of all to make sure that the person best able to help is available.



Above. Kitchen glass cupboard with a 3ft. fluorescent lamp beneath opal glass.

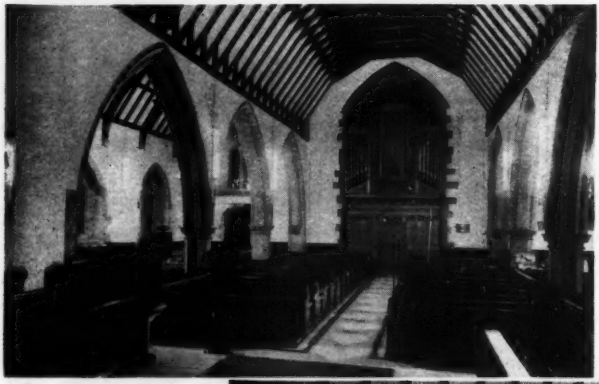
Below: The domestic section. Demonstrations include three methods of stair lighting, curtains illuminated by a fluorescent lamp behind the pelmet and an illuminated niche in a cupboard door.

Fluorescent Church Lighting

A new Installation

By HARRY HEWITT, A.M.I.E.E.

There is a good deal of quiet controversy about the application of fluorescent tubular lamps in the sphere of church lighting. Ecclesiastics and laymen alike have expressed the opinion that such lighting could never be acceptable in an atmosphere of reverence and worship, and this opinion has perhaps been supported by certain installations in which over-eager enthusiasts have applied the fluorescent lamp with little thought for either the dignity or the architecture of a church.



Two views of the interior of St. James's Church, Leyland.

Yet these unfortunate experiences do not mean that the lamp itself is at fault. This dogmatic attitude is based upon a misconception of the possibilities of fluorescent lighting, and a too hasty assumption that such an installation would destroy the beauty of any church. Some churches, though not all, can employ certain features of the fluorescent lamp to harmonise with, and even enhance, their architectural features.

The Vicar and Parochial Church Council of St. James's Church, Leyland, Lancashire, had no definite preconceived ideas when faced with the task of re-lighting their church, but there was a general feeling that suspended fittings should be dispensed with, and since totally concealed lighting was not possible, consideration was given to fluorescent lighting.

St. James's Church was consecrated in 1855, having been built as a memorial to James Nowell ffarington, of Worden, Squire of Leyland. The church is built in Early English style and consists of a nave, north and south aisles and chancel, with a fine buttressed tower at the west end of the nave. The trussed rafter roof is continuous over both nave and chancel and the aisles communicate with the nave by three arches of bold design, supported on octagonal columns with moulded capitals.

When consideration was given to the

possibility of using fluorescent lighting in St. James's Church, three factors, which may well apply to many other churches, at once became apparent:—

(a) The first cost of fluorescent lighting equipment is relatively high, which in this case is not offset to any great degree by reduced current costs, since annual church lighting hours are not considerable.

(b) The use of the bare lamp was unthinkable; not only would the lighting be out of harmony with the atmosphere of the church, but, when not in operation, the appearance of the unlighted tube would conflict with the traditional surroundings.

(c) The fluorescent lamp could not be used in the orthodox manner, i.e., horizontally; this would cut across the architectural lines of the building, for, as is so common in church design, it is the vertical lines that largely contribute to the atmosphere.

Consideration of factor (a) led to the decision to reduce the number of fluorescent lighting units to a minimum, whilst factors (b) and (c) led to the design of a twin tube 40-watt fitting with a "Perspex" diffuser for vertical mounting. The contour of the diffuser was designed to repeat the pattern of the octagonal column, whilst the framework of the fitting was constructed in oak, with oak end-covers, to harmonise with the pulpit and chancel stalls. A careful choice of diffusing material ensured that the two separate tubes would not be apparent, the total effect being that of a softly-glowing column of light. The acceptability of this fitting as a church lighting unit was confirmed when it was demonstrated to the Diocesan Advisory Committee.

The complete installation at St. James's Church consists of 12 of these fittings, together with the necessary reflector spotlamps to light the chancel from concealed positions behind ceiling beams. It was not possible to mount the fluorescent fittings on columns since the arches spring from the capitals at a relatively low height. It was therefore decided to use a position on the spandrel, i.e., immediately above the capital of the column, where the available mounting height gives excellent flux distribution combined with a good appearance. It is noticeable that, owing to the high degree of diffusion, a pleasing illumination of the closely raftered roof is achieved without the necessity for additional lighting units.

"Warm White" tubes are employed in these fittings and the colour mixes well with the concealed filament lighting in the chancel, which is lighted to a slightly higher intensity than the nave. The whole effect has been found most acceptable, and the installation proves that at least one feature of the fluorescent tubular lamp, namely, its low brightness, justifies its wider consideration for the lighting of churches, whilst the physical shape of the lamp can be deliberately employed to good advantage.

The electrical installation was carried out by the North Western Electricity Board, the fittings being specially designed by Siemens Electric Lamps and Supplies Limited.

The 'Mellow' Lamp

A new lamp in the E.L.M.A. range, to be known as the "Mellow" lamp, was introduced by the Electric Lamp Manufacturers' Association on January 1. At present it is available in the 5 ft. 80w. size only.

It is the result of long investigations into the most effective colour of fluorescent light for intimate and domestic purposes, and is outstanding in giving a pleasant atmosphere similar to that created by warm sunlight.

It represents a considerable advance for such purposes as the lighting of dining-rooms, halls, and lounge halls. It is flattering to the human complexion and has a tonic effect after a bleak, cold winter's day outside. It contains more red than the warm-white fluorescent lamp which has been on the market for some considerable time, and will no doubt prove a valuable addition to the present range of fluorescent lamps available in this country.

The I.E.S. Summer Meeting Golf Competition

As at Harrogate, the forthcoming I.E.S. Summer Meeting will include a golf competition for the Dow Golf Cup, which will be played for on the course of the Cavendish Golf Club, Buxton, between May 16 and 19.

The competition will be played on the Stableford System, i.e., stroke play against bogey, points per hole being allotted as follows:—

1 point for a hole done in one stroke over bogey.
2 points for a hole done in bogey.
3 points for a birdie, etc.

To the points so accumulated the competitor will add three-quarters of his handicap.

Competitors may take out as many cards as they please at an entrance fee of 2s. 6d. per card, from Tuesday, May 16 until noon May 19, 1950, inclusive.

A memento will be presented to the winner, and the balance of the entrance fees will be contributed to the E.I.B.A. funds.

Problems in Illuminating Engineering For Students

By S. S. BEGGS, M.A., F.I.E.S.

5. *Materials for Lighting Equipment*

The lighting fitting designer must necessarily know the properties of the materials at his disposal; but the need for this knowledge is not restricted to the fittings designer alone. In planning any lighting scheme a knowledge of the characteristics of different materials is required in order that the right kind of equipment shall be specified, and to avoid a scheme which may appear excellent in theory but prove impossible in practice. That the optical properties should be known seems obvious, but it may not be equally appreciated that the mechanical and thermal properties are of equal importance in practice. It is no use designing a reflector which cannot be made, nor fitting up an installation which is a continuous source of trouble in maintenance and replacement of breakages.

Probably the single material of which greatest use is made, in one form or another, in lamps and lighting equipment is glass. The different grades of glass, and their main properties, should be known. In addition, the usual methods of manufacture of lighting glassware should be studied, for on such depends the most suitable method, or even the possibility of making any particular design of glass reflector, refractor or globe; of these, blowing and pressing are the most important. Coloured glass, for signals or matching filters, is an important but perhaps rather specialised field. Sheet glass is made in a range of varieties; the nature of opal glass and the main factors which affect its diffusing properties are of special interest.

The characteristics as reflectors (of U.V. radiation as well as of light) of the usual materials—polished metals, vitreous enamels, etc.—require consideration, and a general knowledge of their processing, such as anodically brightening of aluminium, glass silvering and vitreous enamelling, is desirable.

For housings and supporting parts, metals are most commonly used. Possible methods of manufacture and the corrosion-resisting properties are important considerations, as unsuitable materials or methods of fabrication can be very costly.

Some other less obvious materials are rubber, for gaskets or insulation, felt or asbestos, sealing compounds for glazing. and plastics — not only of the light-transmitting varieties, such as Perspex, but also the moulding varieties, such as Bakelite, for lampholders and the like. The thermal properties of these materials are as important as the mechanical, for it is often the temperature at which a part will have to operate in use that determines the material of which it must be made.

Question 8 (1941)

Tabulate the chief physical properties which must be considered in the selection of glass to be used for gas or electric lamps and their lighting equipment. How far can these desirable properties be realised in practice?

Discuss carefully but concisely the difference in the behaviour of frosted glass, opal glass and pearl glass for use in the manufacture of electric lamp bulbs. Give approximate quantitative values for the percentage loss of light in the three cases.

Answer

(i) Desirable Physical Properties of Glass for Lighting

The chief physical properties of glass for lamps and lighting equipment which must be considered are:—

(a) Transmission, colour and freedom from flaws.

(b) Transparency or diffusing characteristics.

(c) Thermal expansion coefficient, and ability to withstand thermal shock.

(d) Annealing and working range of temperature in manufacture of glassware.

(e) Mechanical strength.

(f) Durability.

Generally the transmission should be as

The first article in this series appeared in Vol. XLII. No. 9, September, 1949.

high as possible so that the light lost by absorption is a minimum. The transmission is obviously related to the colour of the glass; for tinted and signal glasses it may be relatively low, but for non-selective glass it can be very high. Only the very best quality optical glass approaches true non-selectivity; ordinary sheet glass usually has a green tinge, which is not noticeable unless the glass is unusually thick, and is not a serious disadvantage in general practice. For the best white glass only high grade materials, free from impurities and particularly iron, are used in the glass founding. Flaws, such as stones, bubbles and surface crazing, can be avoided if a good technique in production is adopted.

Clear glass can be made of almost perfect transparency, i.e., producing no measurable scattering of the transmitted light. Different degrees of diffusion can be introduced, but they are not easy to control precisely. Rolled surface patterns are common in sheet glass, and diffusion can also be produced by surface treatment, such as acid etching or sandblasting. The diffusion achieved by these methods is only partial; almost perfect diffusion can be obtained in opal glass, which may be made either in pot or flashed form, without very great absorption of light.

The thermal coefficient of expansion is of first importance if the glass has to make a seal with other material, such as the lead-in wires at the "pinch" of an electric lamp. It is also of importance if the glassware is likely to reach a fairly high temperature in use, and may be subjected to sudden surface cooling, by a draught or rain splash. The lower the coefficient of expansion, the less the chance of the glass cracking in these circumstances. A range of glasses is available, of decreasing expansion, from "soft" soda glass, through the "hard" borosilicates to pure fused silica (quartz).

The "hard" glasses in general require higher working and annealing temperatures and have a shorter working range. They are therefore more costly and difficult to work. However, their use is sometimes essential because of the high temperature at which the glass runs in use.

Although glass is often regarded as fragile, in compression it is as strong as steel, but it is weak in tension and therefore liable to break in bending. This tendency can be overcome to a great extent by pre-stressing the surface layers (so that they are normally in compression) as is done in "toughened" glass; but the range of shapes of glassware to which this process can be applied is rather limited. Ordinary etching or similar surface treatment tends to weaken the glass.

Glass usually is very durable, not deteriorating significantly with age. It does not corrode, in the usual sense, but may lose a high polish if used in certain fume-laden atmospheres.

(ii) Frosted, opal and pearl glass for lamp bulbs

Frosted, opal and pearl glasses are used in lamp bulbs to reduce the brightness of the source. Frosted and pearl glasses do not diffuse completely, and produce a bright patch on the wall of the bulb; opal glass diffuses more nearly completely, so that the whole bulb appears bright.

Frosted and pearl glasses are both essentially clear glass, of which one surface has been made diffusing; in frosted bulbs it is the outer surface, while in pearl bulbs it is the inner surface. The diffusion is produced by tiny surface irregularities, formed by etching with hydrofluoric acid; these scatter the light, within a restricted angle, by refraction at the many small surfaces of different inclination to the incident light from the source. The frosting introduces more loss of light than the pearling, due to some total internal reflection at the facets.

Opal glass consists of small spherical particles of a clear material (usually calcium fluorides) in a matrix of clear glass, of slightly different refractive index. In passing obliquely from matrix to particle and back, the light rays are deviated in many directions, and by suitable choice of size and number of particles and relative refractive index of particle and matrix, excellent diffusion can be produced with relatively low absorption of light. The absorption tends to be higher than that for other glasses, because the length of the light path within the glass, for equal thickness, is appreciably longer.

The absorption for these three glasses is approximately as follows:—

Frosted glass, 5 per cent.

Opal glass 8 to 15 per cent.

Pearl glass, 1 to 2 per cent.

Question 9 (1947)

Give an account of the relative merits of the following materials for use in reflecting equipment:—

Prismatic glass, aluminium, silvered glass, chromium plate.

Mechanical and corrosion-resistance properties should be considered, with examples.

Answer

Prismatic glass may have a very good reflection factor if the glass surface has a high degree of polish. However, the angle of incidence at the glass-air surface must exceed the critical angle (about 42 deg.), which limits considerably the forms of reflector which can make use efficiently of reflecting prisms. The overall coefficient of reflection probably lies between 60 per cent. and 90 per cent.; it does not depreciate significantly if the glassware, and especially the reflecting surface of the prisms, is kept clean. The glass has to be fairly thick for pressing, so is fairly strong but somewhat heavy; it does not corrode. A shop-window reflector is one example of its use.

Plain aluminium has rather a poor reflection factor, but if super-purity grade is used and anodically brightened a very high specular reflection factor (of the order of 85 per cent.) can be obtained. Preferential reflection can be caused by treatment of the surface, but it is difficult to control the degree of diffusion precisely. The metal is very light; it is soft and so easily distorted by rough handling, but is excellent for spinning or pressing. It is liable to corrosion, but the surface can be protected by anodising, which is very successful for dry interior use, but tends to break down where moisture is present. A large operating-theatre reflector is a good example for which it is suitable.

Silvered glass has the highest specular reflection factor (85 per cent. to 90 per cent.), which, if the silvering is well protected, does not depreciate appreciably. The reflector may be formed from sheet, or by blowing or bending; it is fairly light, but is more liable to breakage than a metal reflector. The glass does not deteriorate but the silvering must be well protected or it tarnishes and may blister or peel off; a nickel, copper and good-quality paint backing is desirable, and in severe atmospheres a lead backing may be necessary. It will not withstand high temperatures (in excess of about 200 deg. C.). A floodlight is a typical use of this material.

Chromium plate has only a moderate reflection factor (about 60 per cent.); if kept well polished it does not depreciate, but it is not suitable for inaccessible or damp positions. It can be applied to sheet, spinnings or pressings, if the shape is not complicated, and these, being of metal, are strong. Chromium itself is fairly inert, but it is slightly porous, so that the base metal on which it is deposited must not corrode easily. (Often it is nickel-plated first.) An example of its use is a reflector for a hand torch.

Errata

In the answer to Question 3, page 321, the integral of $2 \sin^2\theta$ is given as $(\theta - \sin 2\theta)$; it should be $(\theta - \frac{1}{2} \sin 2\theta)$. The remainder of the calculation is not affected.

In the answer to Question 5, page 357, one of those inexplicable errors in calculation has occurred. The calculation of the diameter of the mirror should read

$$D = 1.05 \sqrt{\frac{310{,}000}{0.6 \times 1{,}200}} = 21.8$$

and the answer conclude "and have a diameter of approximately 22 inches."

SITUATIONS VACANT

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Personal

Mr. M. Gaughan, B.Eng., A.M.I.E.E., has recently been appointed Electrical Engineer to Britannia Engineering Co., Luton, general engineers and makers of electric light fittings. Mr. Gaughan was for many years in the Lighting Department of the British Thomson-Houston Co., Ltd. Receiving his technical education at the University of Liverpool, Mr. Gaughan graduated in 1927, and joined the B.T.H. Co. in the same year. Apart from a short break in the 1930s, he has been with the company ever since, latterly as a senior engineer in the Lighting Department, at Watford.

Mr. T. H. Windibank, M.I.E.E., on December 31, 1949, relinquished the appointment of Works Director (South), Crompton Parkinson Ltd. He remains a director of the company, with special assignments.

Correspondence

Photoelectric Flash Photometers

To the Editor of LIGHT AND LIGHTING

Sir,—Mr. Munden, in a paper in your November issue, describes a very useful kind of photometer for measuring the total light from a flash in lumen-seconds. May I venture to add a little to this, in a spirit of helpful comment?

During the war such a photometer was designed in the Light Division of the National Physical Laboratory for measuring the time-intensity integral, or visual "punch," of gun flashes. It followed Mr. Munden's circuit almost exactly, but the components were an Osram KMV6 photocell with correction filter (see Journ. Sci. Instrum., **23**, 211 (1946)), an Osram ET1 electrometer triode, and a well-insulated 0.00015 microfarad air-dielectric grid condenser. These, except the filter, were in a sealed metal box (with glass window) containing a silica gel drier. The sensitivity was very much greater than that of Mr. Munden's instrument, because of the much smaller capacity of the condenser. At the same time the stability was equally good, because leakage, in the dried enclosure, was negligible (24 hours after sealing), and the dark emission from the potassium photocathode and the grid current of the electrometer are both very small indeed. In a well-made cell, by the way, the insulation leakage is only rarely comparable with the dark emission. An outer wooden case, about 10 inches cube, contained the whole instrument with miniature batteries, except the microammeter used as the output meter.

In this form the flash-meter travelled many hundreds of miles by air, rail, and road, under adverse conditions, and was also exposed to the blast of guns up to nine-inch calibre at perhaps a couple of hundred feet from the muzzle. It never needed repair, maintained its calibration within ± 5 per cent. throughout, and is still in use with its original components. Anti-vibration mountings were, of course, used for the photocell and valve.

A detailed description was withheld for reasons of security during the war, but reference was made to the circuit and its modes of use in a paper by the writer (Trans. Illum. Engn. Soc. (London), **8**, 121 (1943)), where a paper by the apparent originator of the circuit was also cited.

Immunity from the effect of electrical transients (e.g., from a spark or a flash-tube circuit) can be obtained very simply *without* shielding. One merely switches the valve filament off just before the flash and on again immediately after. This puts out of action the only component capable of rectifying the transient, while the integration of the photocurrent proceeds undisturbed. For this suggestion I am indebted to Mr. W. G. Standring, of the Laboratory.

It needs emphasising, perhaps, that the instrument is very handy for measuring steady intensities or illuminations as well as flashes. In the form here mentioned it competes quite seriously, as regards sensitivity, with direct-reading photoelectric photometers. Its comparative simplicity and cheapness may often outweigh the disadvantage of having to time the rate of deflection of the meter with a stop-watch. For these reasons two copies of the original N.P.L. flash-meter were put to good use during the war for laboratory work involving the measurement of very weak sources of light, when sensitive and absolutely reliable instruments were required at very short notice. They, and the original meter, work quickly and accurately with an illumination of only one-thousandth of a foot-candle incident on the cell with filter. The limit of their range is well below this.

Finally, one must be cautious about applying the results of a static linearity test on a photocell to its behaviour when illuminated by a flash. There are indications that the shorter the flash the higher is the peak photocurrent permissible for a given percentage error due to non-linearity. If this is true, it is good news, but the experimental proof awaits attention by some critical and painstaking investigator.—Yours, etc.,

J. S. PRESTON, M.A., M.I.E.E., F.I.E.S.,
National Physical Laboratory.

Lighting Units

To the Editor of LIGHT AND LIGHTING

Sir,—Referring to "Dimwit's" letter in the November issue, I feel that his pseudonym by no means lines up with the excellence of his argument.

I heartily concur with his objection to the term "lumens per square foot," and I know that this objection is supported by a very considerable body of opinion. I recall also the somewhat scathing comments on the subject by eminent American visitors.

Let "Dimwit" be under no misapprehension: his "masters" have no wish or power to override the views of the majority. If the majority make it clear that they prefer, and intend to retain, the older and more euphonious terms, then the new terminology will die a natural death.

Up the "foot-candles" and down with the "iso-lumens-per-square-foot - diagrammers."—Yours, etc.,

London. MARTIN GAUGHAN.

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Camouflage in Nature

"Things are seldom what they seem."

Account of address given by Dr. H. B. Cott at a recent meeting of the Colour Group.

This aphorism of Buttercup's might well have been taken for text by Dr. H. B. Cott, of the University Museum of Zoology at Cambridge, when he gave his address to the Colour Group on December 9th, at the E.L.M.A. Lighting Service Bureau.

Dr. Cott was responsible for much work on camouflage during the war, and it was interesting to hear him remark that there was no problem of camouflage to which the answer was not to be found in nature if one only knew where to look for it. Camouflage, he said, might be divided into three classes, viz.: (a) concealment, (b) disguise, and (c) display, such as the exhibition of dummies to mislead the enemy. He dealt with these three classes in turn, and by means of many lantern slides showed how they were used in nature and then correspondingly turned to good account in warfare. In nature, for example, certain snakes bury themselves entirely in the sand, except for the head; similarly, ammunition dumps in the desert campaigns were concealed in the same way.

As regards disguise, the examples of this in nature are innumerable, and many are quite familiar, from the moth whose wing markings so resemble the bark of the tree on which it is accustomed to repose that its detection becomes extremely difficult, to the deer whose coat imitates the flecks of light and shade produced by the sun shining through the foliage of the woods in which it feeds. There are, too, the animals that change colour, either at once or seasonally, to enable them to blend better with their accustomed surroundings.

This principle of disguise was extensively used during the war. Objects are recognised by differences of colour or tone, by their outline or by the shadows they cast. The object of camouflage is, therefore, so to alter these factors in recognition that an object may be successfully disguised and, in fact, mistaken for something else. As an example, Dr. Cott mentioned that mules tethered in long lines—the conventional method—were quite unmistakable from the air, whereas if they were tethered in small groups they became quite indistinguishable from clumps of bushes, as he demonstrated with a lantern slide giving an aerial view.

Another example of disguise is to be found in the fish which has on its body a dark band crossing the position of the eye so that this feature becomes quite inconspicuous. Similarly, guns and other munitions which, if dumped in a mass in the centre of a field, would be easily recognisable, could be placed in a long line beside a hedge or ditch and would then escape notice.

The third kind of camouflage, involving the use of dummies, again has its prototypes in nature. For an example Dr. Cott showed a slide of a fish which not only disguised the position of its eye, as described above, but in addition had a black spot, a kind of dummy eye, near its tail, so that an enemy would be led to attack at the wrong end. (Dr. Cott added parenthetically that the fish completed the illusion by swimming backwards, but whether this remark was to be taken seriously the audience could not quite determine.)

Among the many other matters concerning camouflage which were mentioned by Dr. Cott was the use of disruptive markings, of which the most familiar type in nature is the zebra. In order to break up the outline of the camouflaged object most effectively, he said it was necessary for the striped markings to cut across the contours of the object more or less perpendicularly instead of following their general course, and he illustrated this point very convincingly with a slide. So convincing, in fact, were most of the many slides shown during the course of the lecture that any sceptics in the audience were very quickly and completely converted, and they could only regard with amused and contemptuous pity the commanding officer who, when Dr. Cott went to report himself as camouflage officer to the Forces in the Eastern Desert, remarked that "he had about as much use for a camouflage officer in the desert as he would have had for a refrigerator at the North Pole."

New Lighting Installations

Cold Cathode Lighting in the Silk Industry

In order to compete successfully in world markets it has always been emphasised that factories in this country must maintain a high standard of efficiency, and this is only possible with modern technique and up-to-date equipment.

When Messrs. G. H. Heath and Co., Ltd., Macclesfield, decided to build a new air conditioned factory at Talke, Kidsgrove, they invited lighting engineers from Metropolitan-Vickers Electrical Co. to assist in selecting the most suitable lighting for the factory.

Messrs. G. H. Heath and Co. are the largest silk and synthetic yarn throwsters in the British Isles. The business was established in 1872 by George Henry Heath, and for many years produced natural silk yarns for the weaving of the well-known "Macclesfield" dress silk fabrics.

With the advent of rayon yarns and the growing popularity of silk hose for ladies' wear, the business rapidly expanded until to-day the four factories employ some 1,000 operatives.

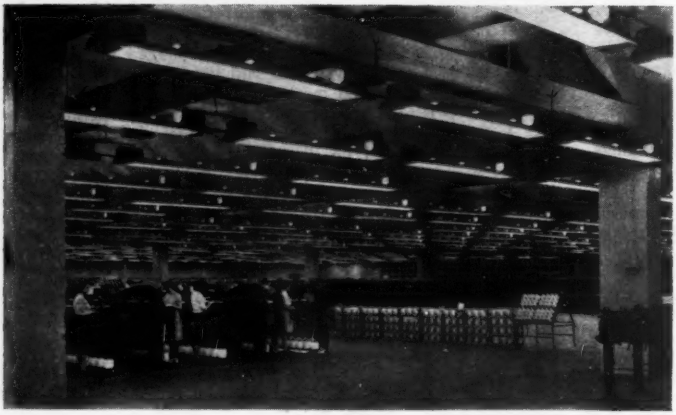
The new factory is air-conditioned throughout, and is of unique design in that it is constructed of reinforced concrete without windows and relies on artifical lighting throughout the 24 hours.

This construction, in addition to demanding care in the type of lighting selected, required special consideration in the method of suspending the fittings. It was also important to create conditions as closely akin to daylight as possible, and accordingly experiments were made with both hot and cold cathode lighting at the firm's Middlewich factory.

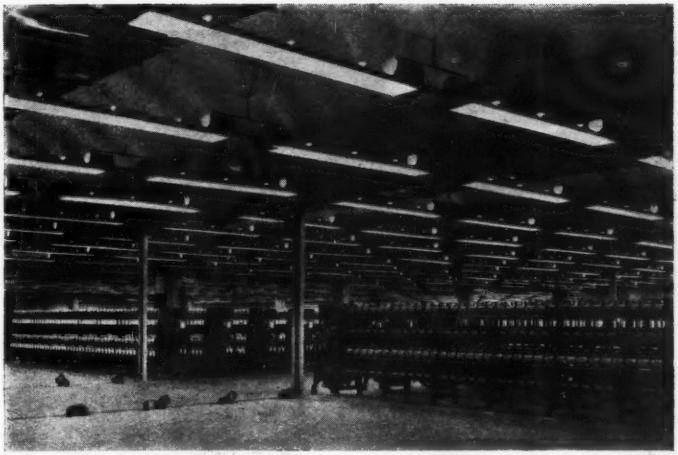
It was decided that the illumination, throughout the working area of the factory, should be not less than 30 lumens per square foot. This has been achieved by using the three-lamp Metrovick cold cathode fitting at 9-ft. centres, with the fittings arranged to give a minimum of shadow between the frames. At the same time, the open tops of the fittings allow light to go to the ceiling, which completely eliminates any tunnel effect and considerably reduces any likelihood of direct glare. In fact the great feature of the lighting of this factory is that the operatives do not feel conscious of working under artificial light.

The lighting is assisted by the use of a suitable colour scheme which, after experiments conducted by the chief engineer and the architect in conjunction with Metrovick Lighting Engineers, was carried out in a shade of pale green

The total lighting load for the main factory is approximately 210 kW., and the installation is one of the largest of its type in Europe. Altogether 844 three-lamp cold cathode units have been installed, representing approximately five miles of tubes.



Cold cathode lighting in the new windowless factory of Messrs. G. H. Heath & Co., Ltd.

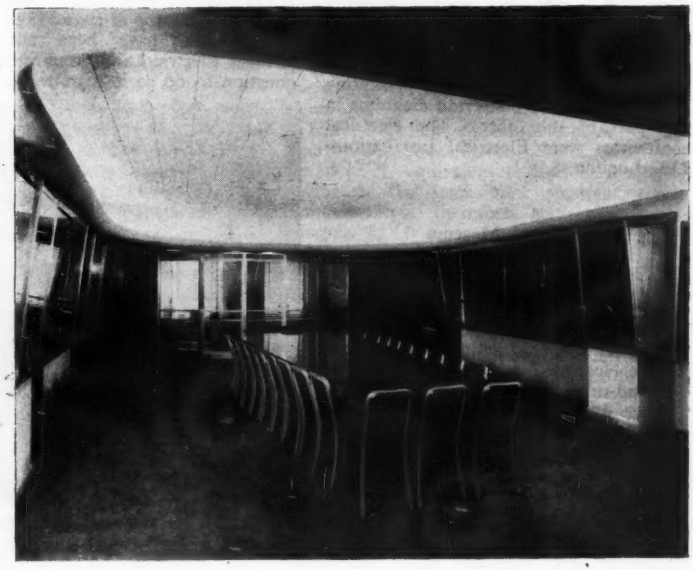


Another view of the Macclesfield factory of G. H. Heath & Co. Ltd.

Conference Room Lighting

The modern conference room, illustrated below, is in the New York office of the Aluminium Company of America. It is lighted by up-to-date 25 mm. warm white cold cathode tubes entirely in cove installation. The light is soft, blending in with the room decor, which includes walnut walls, a brown floor, and a white soundproof ceiling, so providing comfortable seeing conditions.

The 15,000 to 20,000-hour life of these standard Flourescent Lighting Association cold cathode lamps makes for a truly built-in installation that eliminates lamp replacement for many years to come. It is a series type circuit which reduces the electrical installation to a minimum, and one which is utilised both for decorative and illumination purposes.



A conference room in New York lighted by means of cold cathode tubing.

Drawing office at the Metropoliton Water Boardoffices, Rosebery Avenue.

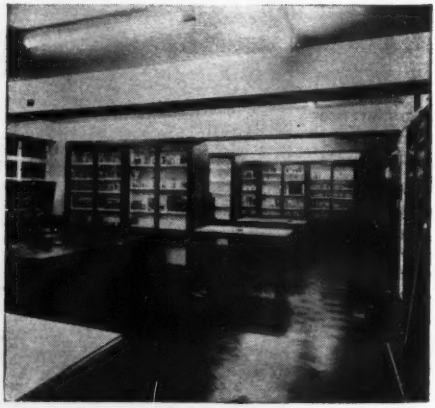
Drawing Office Lighting

The Metropolitan Water Board's new drawing office in Rosebery-avenue, London, has been installed with Benjamin Type "B" Fluroliers, each containing 2 × 40-watt 4-ft. lamps. The photograph below illustrates the high standard general lighting obtained, with minimum shadow, facilitating work and permitting ready reference to plans and diagrams in any part of the office. The electrical contractors were Electrical Installations, Ltd., London, S.W.1.

Hospital Museum Lighting

An installation of Osram 5-ft. 80-watt natural colour fluorescent lamps in G.E.C. single-lamp channel fittings, has replaced the former tungsten lighting in the museum at The Hospital for Sick Children, Great Ormond-street, London, W.C.1. An average illumination of 15 to 20 lumens per sq. ft. is provided throughout the room, an important requirement here being adequate lighting of the tables on which the specimens are normally examined, and of blackboards which are suspended from the ceiling beams during exhibitions and lectures. The general lighting of the room is provided by three fittings to each ceiling panel, and this is found to give adequate illumination for the interior of the showcases.

The photograph of an installation which appeared at the top of page 353 of our December issue should have been acknowledged to Siemens Electric Lamps and Supplies, Ltd. Our omission to do so is regretted.



The museum at The Hospital for Sick Children at Gt. Ormond Street.

I.E.S. ACTIVITIES

London

A paper entitled "Discomfort Glare and the Lighting of Buildings" was presented by Mr. P. Petherbridge and Dr. R. G. Hopkinson at the London meeting on January 10.

One of the recent trends in the lighting of buildings has been towards the provision of much higher levels of illumination. These higher levels have often been achieved by increasing the brightness of lighting fittings or the size of windows. It has been found that although benefit is obtained from the higher illumination levels, this may be offset to some considerable degree by the discomfort caused by bright light sources creating a condition of glare.

It has long been recognised that glare can have several effects on vision which can be differentiated under the broad headings of Disability and Discomfort. A considerable amount of knowledge has already been acquired of the disabling effect of glaring light sources, whereas investigations of the discomfort due to glare have been restricted to limited fields.

In particular, information was lacking of the discomfort glare due to large sources, and it was to the investigation of this problem that the work reported in this paper was directed.

The observational techniques and apparatus employed were similar to those of a previous study in which discomfort glare under street-lighting conditions was studied.

The investigation demanded a means of appraising different glare conditions, a method which has become known as the "multiple criterion" technique being employed. With this technique the discomfort from a glare source is assessed in terms of four recognisable criteria, a "control experiment" being used to determine the reliability of an observer and to measure the scatter of his observations.

The apparatus comprised a model room into which the observer looks, an essential feature being independent control of the brightnesses of the glare sources and their surroundings.

The influence on discomfort of the brightness, intensity and apparent area of a glare source, and the general brightness of the surroundings has been investigated and a single empirical formula has been derived relating the brightnesses of the source and its background, the apparent area of the source and the degree of glare. It was found that a slightly less than proportional increase in the surround brightness was necessary to compensate for a given increase in source area to maintain a constant degree of glare whilst a considerably more than proportional increase in the surround brightness was necessary to maintain this constancy when source was increased in brightness. This explains why lighting installations which have provided high values of illumination only by the use of bright light sources are unsuccessful.

The effect of the shape of a source on discomfort glare has been examined, it being found that under the same conditions of source and surround brightness, a long source, such as a fluorescent lamp, mounted horizontally is no more glaring than a square source of equal area, but that a long source mounted vertically can cause a greater degree of glare. The effect on glare of the position of a source relative to the line of sight has been studied. It was found that for displacements up to about 20 deg., there was only a slight variation in glare and no significant difference in the effect of equal horizontal and vertical angular displacements of the source. It has been shown, however, that quite considerable reductions in discomfort can be effected by removing the source beyond 45 deg. from the line of sight.

The effect on discomfort glare of a number of sources in the field of view was found to be equivalent to that of a single source of the same total apparent area. To this extent, therefore, glare effects are additive.

The variation of the brightness of the immediate surround to a glare source has also been studied. It was found that both the brightness and width of this surround have an influence on glare, and that in some cases it is possible to reduce the glare from a source by a suitable choice of the brightness of the immediate surround.

Applications to the lighting of buildings of the data obtained from the various studies comprising the investigation have been worked out, together with suggested methods whereby the glare can be reduced. Comparisons have also been made between the results and those of other workers. The investigation has, however, been directed

more towards a better understanding of the basic factors of discomfort glare, rather than to a simplified, but necessarily only partly accurate, formulation of the data.

Sheffield Centre

The December meeting of the Sheffield Centre was held at the Mines Mechanisation Centre of the National Coal Board, West Bar, Sheffield, when Mr. P. L. Ross gave a paper on "Fluorescent Lighting in Mines."

Mr. Ross illustrated his paper by demonstrations and lantern slides, and also by fluorescent lighting installations in the training galleries, where a full-size model coal face and a "duckbill" loader were illuminated. The demonstrations were followed by a lengthy discussion in which members and visitors, including Mr. D. A. Strachan, chief lighting engineer of the National Coal Board, took part.

The audience included many of the staff of the Mechanisation Centre, Mining and Electrical Engineers' Association, colliery managers and executives and I.E.S. members.

After the discussion the staff conducted the visitors round the Centre and gave demonstrations and explanations of the apparatus installed.

Forthcoming I.E.S. Meetings

LONDON

February 14th
Sessional Meeting. Mr. J. W. Strange on "The Dimming of Fluorescent Lamps and its Application to the Theatre." (At the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.) 6 p.m.

March 1st
Informal Meeting. Problems Evening. (Place of Meeting to be announced.) 6 p.m.

March 14th
Sessional Meeting. Messrs. W. E. Harper and P. H. Collins on "The Design of Acrylic Mouldings for Flameproof Mine Lighting Fittings." (Joint Meeting with the Association of Mining, Mechanical and Electrical Engineers.) (At the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.) 6 p.m.

March 28th
Visit. To the Building Research Station, Garston. (Ticket only. A coach will leave 32, Victoria Street, at a time to be announced.)

CENTRES AND GROUPS

February 1st
Mr. G. W. Golds on "Railway Lighting." (At the Minor Durant Hall, Oxford Street, Newcastle-on-Tyne.) 6.15 p.m.

February 2nd
Mr. A. L. Randall on "American Lighting Trends." (At the Agricultural House, Queen Street, Exeter.) 7 p.m.

February 3rd
Mr. A. L. Randall on "American Lighting Trends." (At the Grand Hotel, Bristol.) 7 p.m.

February 3rd
Mr. A. B. Nutt on "Visual Fatigue." (At the Electricity Showrooms, Market Street, Huddersfield.) 7.15 p.m.

February 6th
Mr. H. L. Privett on "The Latest in Electric Lamps." (At the Medical Library, The University, Western Bank, Sheffield, 10.) 6 p.m.

February 9th
Mr. G. Grenfell Baines on "Lighting of Architecture." (At the South Wales Electricity Board Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

February 9th
Mr. J. N. Hull on "Transport Lighting." (At the Demonstration Theatre, East Midlands Electricity Board, Leicester Sub-Area, Charles Street, Leicester.) 6.30 p.m.

February 9th
Presidential Address by Dr. J. N. Aldington. (At the Reynolds Hall of the Manchester College of Technology, Sackville Street, Manchester.) 6 p.m.

February 10th
Mr. Forbes W. Sharpley on "Lighting in the Mines—With Special Reference to Flame-Proof Equipment." (At the Imperial Hotel, Temple Street, Birmingham.) 6 p.m.

February 13th
Mr. G. G. F. Halliwell on "Railway Light Signalling Systems." (At the Lighting Service Bureau, 24, Aire Street, Leeds, 1.) 6 p.m.

February 15th
Dr. W. M. Hampton on "Glass as Applied to Illumination." (At the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.) 6.15 p.m.

February 15th
Mr. D. E. Beard on "Lighting for Sports and Games." (At the Y.M.C.A., Swansea.) 6 p.m.

February 16th
Mr. P. H. Collins on "The Development of Plastics for Lighting." (At the Yorkshire Electricity Board, 43–53, Sunbridge Road, Bradford.) 7.30 p.m.

February 21st
Mr. E. A. Langsdon on "Cold Cathode Lighting Equipment." (At the Lecture Theatre of the Merseyside and North Wales Electricity Board's Showroom, Whitechapel, Liverpool, 1.) 6 p.m.

February 22nd
Mr. W. T. Souter on "The Illuminating Engineer's Approach to Lighting Problems." (Joint Meeting with E.C.A.) (At the Welfare Hall of the City of Edinburgh Lighting and Cleansing Dept., High Street, Edinburgh.) 7 p.m.

February 23rd
Mr. S. A. Wood on "Colour in Industry." (At the Institute of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.) 7 p.m.

February 23rd
Mr. G. A. Jones on "Lighting for Photography." (At the East Midlands Gas Board, Demonstration Theatre, Parliament Street, Nottingham.) 5.30 p.m.

March 1st
Mr. M. W. Peirce on "Floodlighting Practice." (At the Minor Durant Hall, Oxford Street, Newcastle-on-Tyne.) 6.15 p.m.

March 2nd
Mr. D. E. Beard on "Lighting for Sports and Games." (At the South Wales Electricity Board Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

March 3rd
Mr. I. M. Robertson on "Lighting of the Brabazon." (At the South Western Electricity Board Showrooms, Bath.) 7 p.m.

March 3rd
Annual General Meeting. Mr. A. M. Steel on "School Lighting—The Architect's Problem." (At the Imperial Hotel, Temple Street, Birmingham.) 6 p.m.

March 3rd
Mr. W. Imrie-Smith on "The Latest in Electric Lamps." (At the Electricity Showrooms, Market Street, Huddersfield.) 7.15 p.m.

March 6th
Mr. J. K. Frisby on "Shop Window and Display Lighting." (At the Medical Library, The University, Western Bank, Sheffield, 10.) 6 p.m.

March 9th
Mr. W. R. Stevens on "Film Studio Lighting." (At the Demonstration Theatre, East Midlands Electricity Board, Leicester Sub-Area, Charles Street, Leicester.) 6.30 p.m.

REVIEW OF BOOKS

"Sight Light and Efficiency," by H. C. Weston. pp. xiv + 318. 132 illustrations (13 coloured). Royal 8vo. 42s. (H. K. Lewis. 1949.

It is often suggested that in this country we lag behind in our application of scientific research to practical problems, but no such criticism could be levelled at Mr. Weston, who has devoted a major part of his life to what we might term "applied vision." Now he has given us a comprehensive account of the subject based very largely on his own first-hand and extensive experience.

The book, which is profusely illustrated, deals not only with the nature of different visual tasks and with the influence of lighting on their performance, but also with vision itself, the causes of eyestrain and the testing of eyesight. While the newcomer to illuminating engineering will find it an indispensable text-book for these aspects of the subject, the acknowledged lighting expert will find many items of interest which are either novel in themselves or discussed from a novel angle.

The author is not content, however, with writing a cold, formal text-book; throughout the book he is championing a cause—the better care and the better use of the eyes. The means he advocates may be more light; sometimes it is an improved light distribution; where appropriate, it is the extended use of optical aids for near work. Towards the end of the book, Mr. Weston urges a wider pre-vocational testing of eyesight, which he considers need not necessarily be undertaken by oculists or ophthalmic opticians. It will be interesting to watch the professional reaction to this suggestion!

The sections dealing with the causes of eyestrain deserve to be studied with special care, because illuminating engineers have not always appreciated the essentially muscular origin of visual fatigue. It is instructive to compare Weston's treatment of the subject with that given at rather greater length in Carmichael and Dearborn's recent book, "Reading and Visual Fatigue." Some points of disagreement emerge, but as the matter is complex, we need not be surprised at this.

Mr. Weston has unearthed a number of fascinating quotations from the classics, although whether the phenomenon referred to in the quotation from Lucretius on p. 99 is really a small field effect rather than diminished selective absorption in a thin layer or single fibre, is a matter of some doubt. There might perhaps have been a more generous supply of references to modern work, and one notable omission is to the "Report on Defective Colour Vision in Industry," published a year or two ago by the Physical Society. References to such matters as the fluctuating action of the ciliary muscle, mentioned on p. 42, would also have been of value.

The diagrams are generally very good indeed, many of them being in colour, but at first sight Figure 5 appears to illustrate a kind of reversed chromatic aberration. Mr. Weston has several pertinent comments to make on terminology and has not hesitated to coin a number of new terms. At times his use of existing terms has not seemed too happy, especially when dealing with colour. On p. 99, for example, he refers to the three variables—hue, brightness and shade; presumably shade here corresponds with what is often referred to as saturation, although this is by no means self-evident from the next few sentences. Objection must certainly be taken to the use of the word "shade" with this connotation.

The remarkable freedom from printer's errors is probably a tribute not only to the author's careful correction, but also to the clarity of the printing and to the conditions of good lighting under which the proof-reading was no doubt carried out.

W. D. W.

"Glass-to-Metal Seals." By J. H. Partridge, D.Sc., F.S.G.T. Published by the Society of Glass Technology, Sheffield. 1949. Pp. 238 + xii with 38 plates and 98 figures. Price 35s.

Dr. Partridge reviews the very extensive literature and brings under one cover the scattered data about glasses, metals, metal oxides, and the techniques employed in making glass-to-metal seals. The treatment is comprehensive, and this book may well become the standard textbook on this rather highly technical subject. For the user of glass-to-metal seals there are useful chapters on the measurement of the strain in the glass and the effect of heat treatment, which go as far as the written word may in interpreting the various effects to be seen in a strain-viewer. There is an interesting statement of a theory for evaluating the principal stresses in a seal, showing how detailed is the work necessary in the proper design of a seal but requiring considerable simplification before this work can be fully appreciated. Some of the new techniques used with silica and hard glasses for high-temperature working are described, and there are also chapters on metal-ceramic and glass-ceramic seals.

This book was prepared for the Society of Glass Technology, and the standard of editing and printing is of the same high order as the Journal of that Society. The photographs and diagrams, some of them coloured, are clear and there is a good index.

J. G. H.

POSTSCRIPT

By "Lumeritas"

The Factory Inspectorate is in a better position than anyone else to follow the trend of industrial lighting practice, for about a quarter of a million visits to factories are made by the Inspectors every year. Even though Factory Inspectors must observe many things besides lighting, their reports upon the latter enable the Chief Inspector to include in his annual report a valuable section upon the state of factory lighting. The most recent of these reports* deals with the year 1948, and I am devoting my page this month to the substance of the Chief Inspector's remarks concerning both lighting and colour.

Steady improvement in lighting conditions was noted and frequently the general cleaning-up of factories was accompanied by the overhaul and improvement of existing lighting arrangements or by the adoption of new installations. Most new factories were found to be provided with ample roof windows, sometimes as much as 60 to 80 per cent. of the roof area being glazed. The trouble and expense involved in normal window cleaning is a reminder, says the Chief Inspector, that while daylight is the best and probably the cheapest form of lighting it is not obtained for nothing.

So far as artificial lighting is concerned, it is gratifying to find it stated that "it is rare to find a new factory in which the lighting installation is not of a reasonably good standard." The Chief Inspector observes that the ample supply of fluorescent tubes is the main factor in this state of affairs, and that complete fluorescent lighting units can be fitted by the uninstructed. So can other lighting units, but the fitting of fluorescent units by persons unversed in the art and science of lighting certainly does not always result in good lighting; on the contrary, I do not think there is any doubt that this practice is responsible for some of the complaints made about fluorescent lighting.

As to the popularity of fluorescent lighting the Chief Inspector says that this is maintained, although there has been some reversion to tungsten lighting in larger factories. He refers to some lighting schemes, designed to give so-called shadowless lighting by means of high-mounted rows of fluorescent tubes, as giving disappointing results. Workrooms so illuminated have been considered dreary and featureless until local lighting was added, "not to kill shadow or obtain higher intensities but rather to provide a 'focus' to draw the eye to the job." Mention is made of the conversion of a purely utilitarian lighting installation in a windowless factory to a system of lighting by artificial windows. This installation was described and illustrated in LIGHT AND LIGHTING for December, 1948.

Factory Inspectors still report glare as the main problem in work rooms not lighted by fluorescent tubes, whereas with tube lights the main difficulty is "top gloom" in lofty buildings. Improvement in artificial lighting has been most marked in paper mills, lace factories, steel works, tinplate works, potteries, brick works, iron foundries, and woollen and worsted industries. On the other hand, gas works, warehouses, docks and building operations, woodworking factories, railway factories, printing works, and yards in nearly every industry are still backward. The Chief Inspector particularly deplores the low standard in some woodworking factories where the maintenance of good standards is essential for safety, special lighting requirements being, in fact, contained in the Woodworking Machinery Regulations.

The Report has as much to say about colour in factories as about lighting. The use of colour in factories was extended during 1948 and many Inspectors think it is gradually becoming standard practice. Colour schemes have been noted in a wide variety of factories both large and small, and a marked improvement on the lighting has been observed where light colours have been used. The favourite colour scheme seems to be cream and green, although there are plenty of variations. A tendency to apply "cool" colour schemes in hot processes and vice versa is noted with approbation. Inspectors have reported that the choice of colour is not always wise but, as more firms are seeking the advice of painting consultants it may be expected that unsuitable colour schemes will not occur frequently. The Chief Inspector is confident that the use of colour is not a "flash in the pan" but has come to stay, and the view is expressed that even in naturally dirty industries it should always be practicable to maintain parts of the premises which are most often seen, in tolerably colourful condition.

* Cmd. 7839, H.M.S.O., price 3s. 0d. (Dec., 1949).